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TABLE OF CONTENTS.

LEADING ARTICLES:	Page.
The Equipment of the Cement Mill of the Portland Cement Company of Utah (illustrated); Leroy A. Palmer	243
The Water Purification Plant of the Chicago Stock Yards	245
Progressive Subsidence Near Main St., Cambridge, Mass., and the Design of the Main Street Subway (illustrated); Frank H. Carter, Assoc. M. Am. Soc. C. E.	246
Valuation of the Track of the Detroit Street Railway System (tables)	249
Cost-Keeping in the U. S. Reclamation Service (illustrated); D. W. Murphy, M. Am. Soc. C. E.	250
Fire Hose Tests at the Underwriters' Laboratories, Chicago, Ill.	253
Operating and Maintenance Costs of Locomotive Coal and Ash Handling Stations; Henry J. Edsall	254
Mechanical Properties of Copper-Nickel Steels Made from Electrolytic Iron and Monel Metal (illustrated)	256
Forest Planting in Kentucky; J. B. Atkinson	257
Floating Two Steel Tanks from Dry Tortugas, Fla., to Key West, Fla.; Dewitt C. Webb, M. Am. Soc. C. E.	257
Traffic on the River Seine, France	257
Charles Talbot Porter (with portrait)	258
A Roller Thrust Bearing Sustaining a Load of 2,250,000 Lbs.	261
Caissons for the Main Piers of the New Quebec Bridge; Launch of the North Pier Caisson [contributed] (illustrated)	262
The Strengthening of Railway Track for High-Speed Traffic	263
Freight Unloading System at Manaos, Brazil (illustrated); Charles J. Seibert.	264
EDITORIAL	259
Subsidence of Ground at Cambridge, Mass.—High Water Consumption and Few Meters at Spokane, Wash.—The Growth of New York and Other Cities—Defects Shown by Fire Hose Tests—Forest Planting—Storage Battery Vehicles to Replace Horse Cars in New York City—Dress Parade Road Conclusions.	
Track Development for High-Speed Train Service	259
LETTERS TO THE EDITOR	261
Changes in the Level of Great Salt Lake and the Lucin Cut-Off of the Southern Pacific Ry. (illustrated); E. C. LaRue—Engineering Societies and Professional Conduct; Charles H. Higgins—Notes and Queries.	
ENGINEERING NEWS OF THE WEEK	265
PERSONALS	269
ENGINEERING SOCIETIES	266

The Equipment of the Cement Mill of the Portland Cement Company of Utah.

By LEROY A. PALMER.*

The equipment of the Portland Cement Co. of Utah, both at quarry and mill, has recently been thoroughly remodeled so that the operations thereat are of some interest as presenting an example of the most advanced type of cement manufacture.

The quarry is situated in Parley's Canyon, close by the Park City branch of the Denver & Rio Grande R. R., and nine miles from the plant in Salt Lake City. The ground owned by the company extends for nine miles along the canyon with a maximum width of 3½ miles, containing a combination of rock such as is suitable for the manufacture of Portland cement of high quality. As is well known, the chief ingredients of good cement are silica, iron, alumina and lime in certain proportions, to obtain which it is necessary to mix two or more different kinds of rock. In this case the desired result is obtained by mixing an almost pure limestone with a calcareous shale, both of which are found in the Parley's Canyon quarry, occurring in alternate beds.

The remodeling and re-equipping referred to called for the expenditure of a considerable sum, so before it was finally decided upon a large portion of the ground in the canyon was prospected to determine the value of the deposit. This prospecting was carried on by means of shafts which were made 3 × 3 ft., only sufficient size for one man to work, and carried to a depth of 25 to 80 ft., as the case required, by hand. Their object primarily, was to determine the extent and thickness of the different beds, but they were so placed that when active quarrying operations were commenced they were used for blasting, although it was necessary to sink other shafts in between to make the blasts fully effective. With the installation of the machinery at the quarry air hammer drills are used for sinking. The shafts are so placed as to give a burden of 30 to 40 ft. from the face for blasting. When down to the desired depth they are chambered at the bottom, loaded with Trojan powder and fired by means of a battery. The Trojan powder has been found to give good satisfaction in this work, combining some of the features of dynamite and black powder, and one shot is on record where 900 lbs of powder moved 30,000 tons of rock.

FIG. 1. VIEW OF THE RAW GRINDING KOMINUTERS, PORTLAND CEMENT CO. OF UTAH.

The broken rock is loaded to small push cars and trammed to the crusher house, which is not over 50 ft. from the present working face. Here the car runs onto a cradle which automatically dumps it to the crushing floor in which is a No. 7½ Gates gyratory crusher set to crush to 2 ins., discharging to a pan elevator which raises the product to the bins. With each revolution of the elevator belt a butterfly gate is thrown open and the contents of one pan thrown out as a sample. This sample is passed through a laboratory crusher, cut down to about 5 lbs., labeled and sent to the laboratory at the mill for analysis. The elevator discharges to a horizontal belt conveyor, which is rather unique in its action. The conveyor is one-half the length of the bin and is mounted on wheels which run on a track of T-rails. A rope drive imparts motion to the belt and a double solid jaw clutch permits of its direction being reversed. Another clutch throws in the connection between the belt pulley and the wheels, so that it can be moved back and forth along the rails, thus bringing one end or the other over any one of the eight bins. This point is quite essential as the different lots are kept carefully segregated from the time they are quarried until the treatment at the mill. The bins have flat bot-

*Mining Engineer, Salt Lake City, Utah.

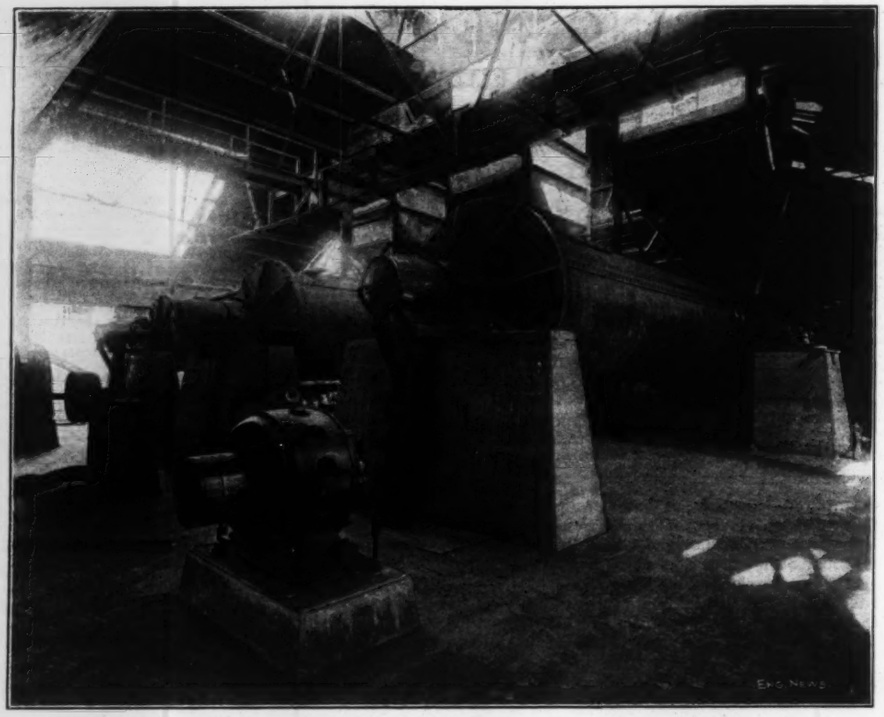


FIG. 2. TUBE MILLS FOR GRINDING RAW MATERIALS.

tom with a sliding center discharge gate to the railway cars which are run beneath on a siding.

Power for the crushing and hoisting machinery is furnished by a 100-HP. return tubular boiler and a 16 × 20-in. slide-valve engine. Air for the drills is furnished by an 8 × 8 × 10-in. straight line compressor.

The rock sample is analyzed at the mill laboratory, and the chemist advises the mine foreman which of the eight bins to ship. The rock is delivered in specially built side dump steel cars to the mill bin, which is a hopper shaped of steel, and fed from it to an inclined conveyor which dumps to a steel housed elevator. A commendable practice which is followed throughout the plant is employed at the elevator. This elevator is of the chain and sprocket type with the bottom pulley connected by chain and sprocket to the driving pulley of the feed belt, the latter receiving its motion from the elevator. Thus in case of accident to the elevator the feed is automatically cut off and there is no filling up of the boot with feed as is so often the case.

The elevator discharges to a set of 40 × 15-in. rolls of the Anaconda type set to crush to 1 in. and discharging to another elevator which dumps the rock to the drier. The drier is a large revolving tube, resembling a tube mill or kiln, making a revolution in 14 secs. A coal fire is maintained in a brick firebox at one end and the flames strike down against the crushed rock and drive off all moisture, which is quite essential to the process. The drier has sufficient pitch that the feed works out of the lower end from which it goes to an elevator and is raised to the pan conveyor. This consists of an endless series of pans, each mounted on four wheels running on a track over the mill storage bins. Over each bin is a short stretch of track curving sharply downward beneath the straight track. At this point the straight rails can be swung outward so that the pan will follow the curved track downward and dump its contents into the bin beneath. In this way the dried rock can be dumped to any bin that may be desired.

Each storage bin terminates in a steel hopper in which is a lever-operated gate and, beneath, a swinging gate operated by an eccentric. By means of these two gates the feed from each bin may be regulated as closely as may be desired. These hoppers feed to a rubber belt conveyor and here occurs one of the most important steps in the process.

An analysis of the limestone or No. 1 rock shows:

Calcium carbonate	80.7%
Silica	10.3
Aluminum and iron oxides	6.2
Magnesium carbonate	2.5
	99.7%

Shale or No. 2 rock:

Calcium carbonate	52.0%
Silica	28.5
Aluminum and iron oxides	14.5
Magnesium carbonate	4.5
	99.5%

These rocks, the composition of which will, of course, vary more or less from the above analyses, must be mixed in such proport to present a mix of the following compos

Calcium carbonate	62.
Silica	22.
Aluminum and iron oxides	10.
Magnesium carbonate	2.
	97

It will be seen that the proportion of sium carbonate given in the last analys not be formed from the two lots taken example, but this is not essential magnesium and the lime have the sam actions in the kiln and the one will repl other.

As stated, the different kinds of rock a contents of the several bins are kept se so that the chemist knows the exact comp of the rock in each of the storage bins mill. From this he figures his mixture and his instructions. The feeder to one bin t is to be used is started and the amount can on one complete revolution of the conveyor b is carefully weighed. The process is repeated with another bin and the feeders adjusted until exactly the correct proportion is obtained, when both feeders are started and the contents of both bins mixed on the belt.

The belt beneath the storage bins discharges to an inclined conveyor to an elevator which raises the rock, now mixed in the proper proportions, to a belt conveyor, which carries a tripper by which it is discharged to any one of the kominuter bins. There are two Lindhard kominuters and one Allis Chalmers ball mill. A pipe carries the feed from the bin to a revolving table which discharges it to the kominuter. The kominuter is like a ball mill with two annular screens of different mesh. The oversize of both screens is returned to the mill and the undersize discharges to a hopper beneath. This undersize will all pass a 20-mesh screen and 35% will pass a 100 mesh. The kominuters have a speed of 22 r. p. m.

The hopper discharges to a screw conveyor beneath the floor which carries the feed to an elevator, the scheme of having the elevator drive the feeder being followed. The elevator raises the now finely ground rock to the tube mill bins from which it is fed to three tube mills, two 6 × 22 ft. and one 5 × 22 ft., making 26 r. p. m. These roughing tubes, as they are called, pulverize the rock so that 95% will pass a 100-mesh screen and discharge it to a screw conveyor to an elevator, which dumps it to the bins above the kilns, of which there are two.

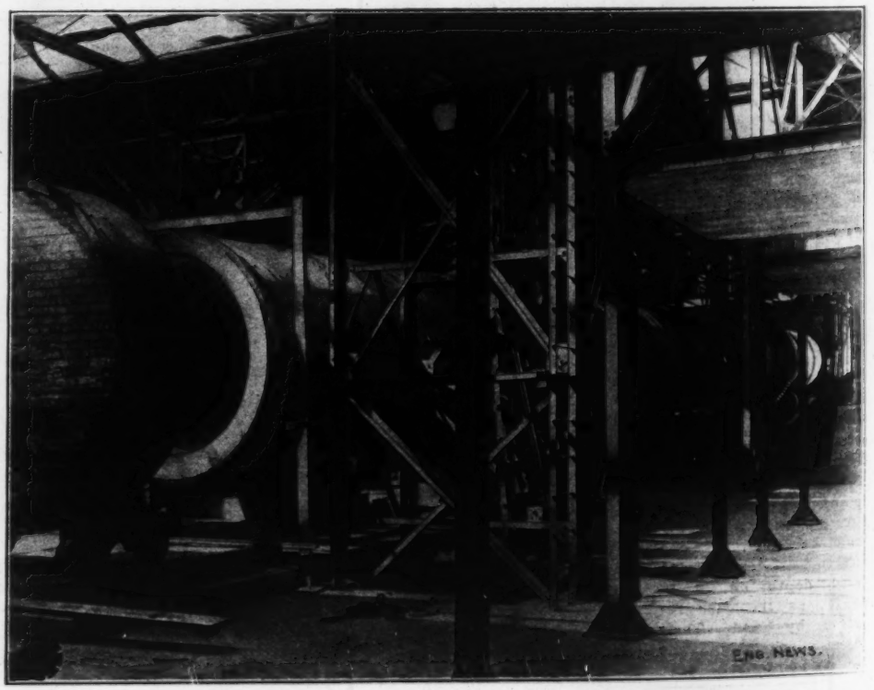


FIG. 3. ONE OF THE ROTARY KILNS OF THE PORTLAND CEMENT CO. OF UTAH.

Each kiln is a steel tube with firebrick lining 8 × 125 ft. It is geared to a motor so as to make one revolution in 1 min. 40 sec. The kiln has a slight pitch toward the firebox in which a fire is maintained by means of fine coal dust injected by a blower. The powdered rock is readily acted on by the heat, which is kept at 1,800° to 2,000° F. The charge requires from two to three hours to work through the entire length of the kiln, during which time the CO_2 in the carbonates is driven off and the calcium and magnesium unite with the other elements to form silicates, ferrates and aluminates of the following composition: 2 CaO SiO 2, $XCaO\ Fe_2O_3$, 2 CaO Al_2O_3. The proportion of lime in the ferrate varies so a definite formula for it cannot be given. The magnesium acts in the same manner as the lime.

The rock sinters into lumps in the kiln and is discharged through a hole in the lower end to a bucket conveyor which elevates it to a rotary cooler. The cooler is a tube 6 × 60 ft., similar in external appearance to a kiln but open at the lower end, the upper terminating in a stack. The feed enters the higher end and the rotary movement works it toward the lower, during which process the rock is cooled by the heat drawing cold air from the outside through the cooler.

The cooler discharges to the weigh tank in which the weight is carefully taken and the rock discharged to a receiving tank where 2% of raw gypsum is added to retard the set which would otherwise take place too quickly.

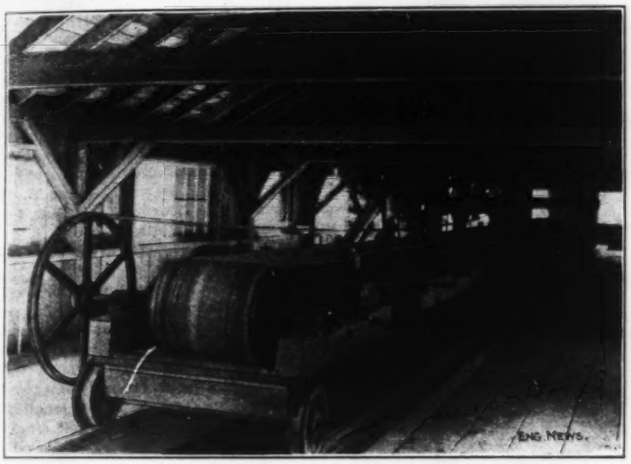


FIG. 4. BELT CONVEYOR AT QUARRY BIN, ARRANGED TO DUMP IN DIFFERENT BINS.

From the receiving tank the rock goes to an elevator which raises it to two kominuters making 24 r. p. m., which reduce it to 28 mesh, 38% to pass a 100-mesh screen, thence it is carried by a screw conveyor to an elevator which dumps to the tube mill bins. The finishing tubes are two in number, 6 × 22 ft., making 28 r. p. m., and grinding so that 95% will pass a 100-mesh screen. The discharge passes over a fine screen which takes out any chips of pebbles which may have been broken off in the mill. The now finished product is carried by a screw conveyor to an elevator which raises it to the stock bins.

The preparation of the coal for the kilns is a process of considerable importance, as it must be reduced to a fineness that will allow of complete combustion immediately on being blown into the firebox. It is unloaded from the cars by a swinging conveyor to a stockpile from which it is fed to a hopper to an elevator and passed through a rotary drier 5 × 10 ft. Thence it goes to a set of 24 × 18-in. disintegrating rolls, thence by elevator to a set of 30 × 14-in. crushing rolls and from them to a 5 × 20-ft. tube mill in which it is ground so that 95% will pass a 100-mesh screen. The dust is elevated to a bin and blown into the kiln by a 30-in. blower with a capacity of 4,000 cu. ft. of air per min., working at a preasure of 1 in. of water.

The plant has a well-equipped laboratory in which the analyses and tests are made. Analyses are made of each lot from the quarry and of the mixed rock. The raw product is sampled hourly and tested for fineness, and hourly samples are taken of the finished product and tested for initial and final set, fineness, soundness and tensile strength.

The plant is working 24 hours and putting out 1,400 bbls. per day, practically a barrel a minute.

The Water Purification Plant of the Chicago Stock Yards.

The water purification plant established by the Union Stock Yard & Transit Co., at Chicago, for the treatment of the extraordinarily foul water from the "Bubbly Creek" arm of the Chicago River, is notable not only for its general purpose and as being the first filter plant to use the hypochlorite treatment continuously, but also on account of the various attacks which have been made against its use. This arm of the river was for many years a dead-end, and its water was made indescribably foul by accumulations of sewage, packing-house refuse and general stock yards drainage and filth. Of late years it has been flushed to some extent by the discharge into its end of the 39th St. conduit, the flow of which is sewage from the south-side intercepting sewer system, diluted more or less by lake water. In any case, the flow is largely fresh sewage, while the stream still receives stock yards drainage and refuse, and its bed and banks are saturated with foul accumulations.

The city's present water pipe and pumping system serving the stock yards district cannot furnish an adequate quantity of water, and in warm weather there are frequent complaints as to insufficient supply, especially in the upper stories of buildings. To supplement the city supply and to reduce the cost for water, the stock yards company a few years ago decided to take the sewage-laden water from Bubbly Creek (which is adjacent to the yards) and to establish a plant for rendering this water safe and acceptable for stock watering purposes. It is admitted, however, that the water was used also for drinking purposes. The plant, which has a capacity of treating 5,000,000 gals. per day, was completed in 1908. At first sulphate-of-iron and lime were used as the coagulants, followed by a copper sulphate treatment. This did not prove satisfactory, however, and hypochlorite of lime was substituted for the copper sulphate, upon the recommendation of Mr. Geo. A. Johnson, of Hering & Fuller, New York City, who tested the plant before its acceptance by the company. This change antedated by a few weeks the regular use of hypochlorite at the Boonton reservoir of the Jersey City water-works. In June, 1909, sulphate of alumina was adopted as the coagulant in place of iron and lime. Tests of the treated water made by numerous water analysts of long experience showed this to be purer bacterially than the raw Lake Michigan water supplied by the city.

Public attention was attracted to this plant on account of the character of the raw water which it treated, and complaints were made that the use of the water was dangerous. The analyses made by experts disproved these claims, but the city authorities and the Health Department continued to object, the principal ground of objection being that it was bad sanitary practice to use "treated sewage" (as the Health Department termed it) for public or private water-supply. In February, 1909, the city passed an ordinance to prevent the use of the treated water for anything but mechanical purposes (such as supplying the boilers, washing the floors, etc.), and brought suit against the company for violation of the ordinance. The company has already presented its side of the case, with evidence as to the quality of the water.

As another phase of the matter, an association of live-stock shippers later made complaint that the water was not suitable for the cattle, one special claim being that animals drinking it made less gain in weight than those using the city water. This statement was sent out broadcast to farmers and cattlemen, with the suggestion that unless the company would agree not to use the water the shippers should send their cattle to other cities. As this question of weight of animals affected the price it served to prejudice the cattle shippers. The company claimed that tests made by it and by the disinterested experts engaged by it showed that there was no appreciable difference in the effect of the two waters. As a result (in part at least) of the city's opposition, and in order to avoid a prejudice that might affect its business, the company discontinued the use of the water in April, 1910, and the plant is now out of commission. It is uncertain whether the company will take steps to resume its operation.

It is of interest to note that some months ago a company which was organized in the stock yard's interest applied to the city for a franchise authorizing it to build an intake tunnel and to supply water in this district. This was attacked very strongly by the council, partly on the detail of its omission to provide for suitable compensation to the city. But the strongest opposition was upon the general principle of the undesirability of empowering a private company to enter into competition with the city's water-supply system, and with the specific purpose of cutting off a part of the city's revenue from this system. No franchise has been granted, and the project is either sleeping or smothered.

The foregoing review of the conditions as to the water purification plant presents the matter largely from the point of view of the stock yards company, which has furnished us with considerable information. We have submitted the matter to Dr. W. A. Evans, Health Commissioner of Chicago, and at his request a statement of the city's side of the case was prepared by Dr. F. O. Tonney, Director of the Municipal Laboratories. This statement we give below:

At the outset it may be stated that there was no disposition on the part of the city's experts to discredit or underestimate the value of the hypochlorite process as applied to water supplies in general. It is believed to be a valuable addition to methods of water purification already recognized. It is not believed, however, to be applicable to the conversion of a fresh sewage directly into a potable water. As expressed by a prominent sanitary engineer connected with the case, the willingness to advocate such bad sanitary practice as the use of a treated sewage for a public or private water supply, is explainable only on the supposition that it is due to that over-enthusiasm which so commonly follows the advent of a new discovery, before its true limitations have been recognized.

The only evidence actually introduced by the city consisted in the testimony of Prof. C. E. A. Winslow, of the Boston Institute of Technology, covering several days of direct and cross examination. Further evidence was dispensed with as a result of an agreement on part of the company to discontinue the use of the water and install a concrete reservoir for storage of city water to replace the open pond then in use. The case is now definitely closed.

It should be remembered that the chief inducement favoring the use of the treated water was the fact that the cost of production was materially less than the price of city water. The question of shortage of city water was not important, as it had been remedied by allowing the water to flow into a reservoir over night for use on the following day.

Briefly the salient points of the city's case which would have been brought out, but for the early settlement of the suit, are as follows:

(1) That the water was being used daily for human consumption as well as for the watering of cattle. Ample evidence was available on this point, including the reports of inspectors stationed in the yards. [This is admitted by the company.—Ed.]

(2) That the results of analyses introduced in the case, were susceptible to different interpretation from

that represented by the conclusions of the company's experts, which were based on bacterial findings alone.

(3) That the finished product of the plant still contained in solution 50% of the original organic matter of the sewage. It was the opinion of eminent toxicologists and physicians that this amount of organic matter derived from urine, faeces, and decaying slaughter wastes would exert a toxic influence on persons drinking the water continuously. This to a certain extent was supported by animal experiment.

(4) That bacteriologically the disappearance of the colon bacillus, while a good index of the elimination of disease producing organisms, by natural processes and by filtration, is not an adequate index of the effect of disinfectants, because of the varying degree of resistance of different kinds of organisms to germicide. Experiments made at the University of Chicago by Dr. P. G. Heineman to determine the germicidal effect of chloride of lime in the strength used at the plant (7 pts. per million), upon the ordinary pathogenic bacteria, showed a material numerical decrease in all cases. But in no case, even after 24 hours' exposure, were the emulsions rendered sterile. Tubercle bacilli and anthrax germs were neither destroyed nor reduced in virulence for guinea pigs, by the combined alum and hypochlorite treatment.

(5) That from the standpoint of sanitary engineering: (A) Such a stream, containing [carrying—Ed.] one-third of the entire sewage of Chicago, and much stockyards drainage, cannot be recommended as a proper source for drinking purposes.

(B) The principle of establishing a single safeguard, however efficient when in good order, between fresh sewage and the consumer, is bad sanitary practice. The possibility of a break in the efficiency of the plant, through mismanagement, carelessness or accident should be considered. It was admitted that the filtration alone was not adequate to remove the bacteria. If, therefore, the essential step (the addition of hypochlorite of lime) should be interrupted, even for a few hours, a serious epidemic could result.

(6) That in view of the special environment and conditions surrounding the plant, certain other diseases not commonly thought of as water-borne should be considered. The slaughter of large numbers of tubercular animals, the waste from which flows into the stream, together with the fact that this district is a central focus and distributing point for cattle from every part of the country, makes it necessary to consider the possibility that tuberculosis and anthrax may be capable in this special instance of being water-borne. Both of these organisms were found to be unaffected by hypochlorite of lime in the concentration used at the plant.

(7) That the reservoir in which the treated water was stored before passage into the mains, was a flagrant source of pollution; in fact that any water no matter how initially pure, would be rendered unsafe by passage through this reservoir. It is bounded on three sides by runways, two of which are built out over the water. Hundreds of animals pass over these runways daily—and fecal pollution is constant. Evidence of human contamination also were discovered by the inspectors. Sick animals or "downers" were kept in wooden pens built out over the water. Colon tests were positive on 10 to 20 days out of each 30. A rise in bacterial count and colon content during a rain or thaw gave ample evidence of contamination by surface drainage. It is, of course, manifest to one familiar with the yards that surface drainage in this neighborhood must mean enormous fecal pollution.

(8) That it is unsafe from the standpoint of precedent to entrust to a private corporation not primarily engaged in the water business so important a function as the control of public water supplies.

(9) Finally, that the city water is a pure and wholesome supply. In fact that the city of Chicago is unusually fortunate in this respect. That the bacterial counts, while higher than the treated water, are of different significance in that they are the ordinary forms natural to water. That positive colon findings are not obtained in city water in a sufficient number of instances to cast suspicion on its safety as a general supply.

Progressive Subsidence Near Main St., Cambridge, Mass., and the Design of the Main Street Subway.

By FRANK H. CARTER.* Assoc. M. Am. Soc. C. E.

In the fall of 1897 while engaged in an investigation of facts concerning back flooding from sewers in a low area of Cambridge, Mass., the writer, as assistant engineer under the direction of L. M. Hastings, City Engineer, discovered some discrepancies between certain bench marks. The only previous difficulty noticed had been a supposedly local settlement of what was known as Orne's bound, one of the city's standard bench marks. It was thought that this bound had merely settled with the sidewalk towards the cellar due possibly to a settlement of the building.

The writer took levels on adjacent curbs, tracks and in several sewer manholes, and discovered the fact that the whole district was settling. In the next succeeding few months some 50 miles of careful bench levels were run to old bench marks of undoubted permanence, some of which were five miles distant from the settled district. Profile levels of the streets in the district itself revealed an area of settlement about one mile square, with two points of maximum settlement and running out to zero on the perimeter. Later, engineers from the office of the Metropolitan Water and Sewerage Board corroborated the settlement, finding that the Metropolitan sewer through Cambridge had gone down two feet at the maximum point.

When the surveys for the Boston Elevated Railway Co.'s extension to Cambridge were made in 1901, under the direction of George A. Kimball, M. Am. Soc. C. E., Chief Engineer, Elevated and Subway construction, further information was obtained, which when compared with the levels which had been taken previously by the writer, showed a fairly uniform settlement of something over an inch a year of the maximum in succeeding years, 1906 and 1909, other from the Boston Elevated Railway Co. further corroborated the settlement, and that the rate of settlement is unabated no promise of lessening.

Heavy buildings on pile foundation wooden buildings, curbs, street railway and sewers all go down at the same rat to 1¼ ins. per year in the center of the district.

It has been necessary to design and co about a mile of the Cambridge Main St. through the settled district in Main St. will happen to the structure itself, which reinforced concrete well tied together with gitudinal reinforcement, as shown in the section Fig. 3, or to the drainage system subway, will of course only be determined a lapse of years.

Fig. 1 is a map of the settled district. is a profile through Main St., Cambridge, with a study of the geological strata as indicated by wash borings made in 1906. Bed rock has been sounded at a depth of from 90 to 100 ft. below the surface, with indications of a thick layer of very soft clay on top, though wash borings are not to be entirely depended upon, as has been revealed by the actual excavation for the subway proper. It was found that "soft blue clay" was a misnomer, when actual excavations for the subway were made, as the so-called soft clay proved very firm. Soft clay may, however, exist down next the bed rock.

Above the main profile a greatly exaggerated set of profiles is given of the various lines of levels run by City Engineer Chase in 1869, on the establishment of a legally accepted grade; by the writer in 1897 at the time of the discovery of the settlement, and by Messrs. Herman Gregg, H. H. Hawkesworth and W. L. Learned, Assistant Engineers, Boston Elevated Railway Co.

Tables I and II list a typical set of observed settlements at different dates.

Another profile has been drawn predicting settlements for certain periods of years in the future, and some provision made for consequent changes in the drainage system of the Subway. The arch section of the Subway through this settled district is reinforced laterally for arch stresses and thoroughly tied together longitudinally as a provision against longitudinal cracks, to distribute concentrated loads, to provide against racking strains in the arch due to excavations on one side as well as to provide for the possible unequal settlements in the settled district.

From the map (Fig. 1) it is reasonable to conclude that the subsidence of the Main Street district is a local phenomenon. There seems to be also a general subsidence of the entire Boston territory (and probably of a large part of the North Atlantic coast), with reference to sea level. The report of the Committee on Charles River Dam, by Mr. John R. Freeman, M. Am. Soc. C. E., presents this matter fully, as concerns the Boston region. The following paragraphs quoted from the appendix to that report, written in 1903, state the facts briefly:

All of the territory in and about Boston is probably slowly sinking relatively to the level of the sea. Apparently this subsidence is at the rate of about one-eighth of an inch per year, one inch in eight years, or a little more than a foot in each one hundred years.

This is obviously a question of great importance in comparing ancient soundings with modern, and in considering the possible future shoaling of the harbor.

The present datum plane to which all elevations are referred by the engineering department of the city of Boston, and which is commonly known as "Boston base," probably coincided almost exactly in the year 1830 with mean low water at the Charlestown Navy Yard. Prior to the Miner levels of 1878 the Boston datum had always been supposed to be at mean low water, and was so marked on the plans made by the city up to 1878.

In 1878 Boston base was found to be about 0.8 ft. below mean low water as determined by the United States Coast Survey at some time just prior to 18[illegible].

To-day, after the lapse of 72 years, this same datum plane, as defined by numerous bench marks on solid ground, according to the best available determinations, is 0.79-ft. below mean low water.

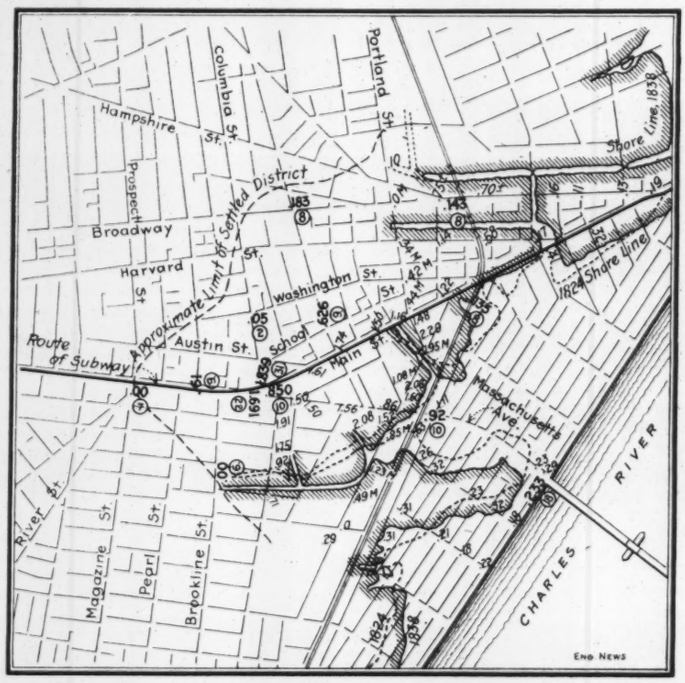


FIG. 1. MAP OF PART OF CAMBRIDGE, MASS., SHOWING REGION OF SUBSIDENCE.

Full shore-line is from map of 1838.
Dotted shore-line is from map of 1824.
Upright figures denote amount of subsidence of benchmarks, in feet. Figures within circles below, where given, are the number of years of observation.
Italic figures denote settlements of sewers, in feet, from date of construction to 1907, when most of the levels were taken. Those followed by M are for Metropolitan sewers.

*Designing Engineer, Cambridge Main St. Subway, Boston Elevated Ry. Co., Cambridge, Mass.

This comparison shows that the land now stands about 0.79-ft. lower relatively to the sea than it did about 72 years ago, and therefore shows that the land in Boston and vicinity is sinking at the rate of about one foot per hundred years.

Making a similar comparison on the basis of mean sea level, instead of mean low water, we find the rate of change is 0.71-ft. in 72 years.

This change affects a very large area, and a variety of independent proofs is offered.

At this rate, the present grade of Atlantic Ave. near foot of State St. (15.0 Boston base) will be awash by the spring tides of each month about 250 years hence.

The proofs of this subsidence in brief are:

(1) The sills and floor of the masonry dry dock at the Charlestown Navy Yard now stand about 9 ins. (0.71-ft.) lower relatively to mean sea level than any did 72 years ago, while the dock stands at precisely the same level relatively to points on solid ground.

(2) The comparison of sundry tide gages, ancient and modern, indicates progressive subsidence.

(3) Many rocks about the edges of Massachusetts Bay are found to be from 1 to 2 ft. deeper below extreme low water now than they were about 90 years ago.

(4) The extreme tides in great storms appear to show progress toward greater heights.

(5) At many points about Boston tree trunks are found standing in salt marsh under conditions that prove a recent subsidence.

I was led to investigate this matter by consideration of statements of Prof. W. O. Crosby regarding the geological causes which had formed Boston harbor, resulting in a submerged valley; and from my observation of the peculiar relation of the datum plane at present used by civil engineers on the Boston public works, known as "Boston base," to the ancient datum plane of "marsh level" and to "mean low water," and because of the unsatisfactory explanations offered as to why "Boston base" was established at the odd distance of 0.64-ft. below mean low water, I was led to investigate the old bench levels.

I had for some years past been interested in the indication of comparatively recent subsidence found in the resemblance of some of our coastal indentations to ordinary valleys that had become submerged, and in studies as to the future water supply of Brooklyn (Report on New York Water Supply 1889-90) I had occasion to review the proofs of recent subsidence offered by the State Geologist of New Jersey, and was therefore the more ready to follow out the indications of the present case.

The general subsidence which Mr. Freeman demonstrates has important bearing on elevations of harbor works, bridges, sewers and the like. On the other hand, the much more rapid local subsidence in Cambridge, above described, affects seriously the structural design and the grades of sewers, subways and other continuous underground structures crossing the district of movement.

Design of the Subway in Region of Settlement.

Fig. 3 is typical of the cross-section of the subway through the greater part of the settled district. The structure was built by the Hugh Nawn Contracting Co. for the Boston Elevated Ry. Co., George A. Kimball, M. Am. Soc. C. E., Chief Engineer, Elevated and Subway Construction; the writer as Designing Engineer; R. B. Farwell, Division Engineer of Construction; and J. R. Worcester, M. Am. Soc. C. E., and C. M. Mills, M. Am. Soc. C. E., Consulting Engineers

The lateral reinforcement of the subway as an arch was determined from an adaptation of the usual elastic arch theory by the writer, and checked by Messrs. J. P. McCann and W. A. Bassett, to whose untiring efforts with the Cain

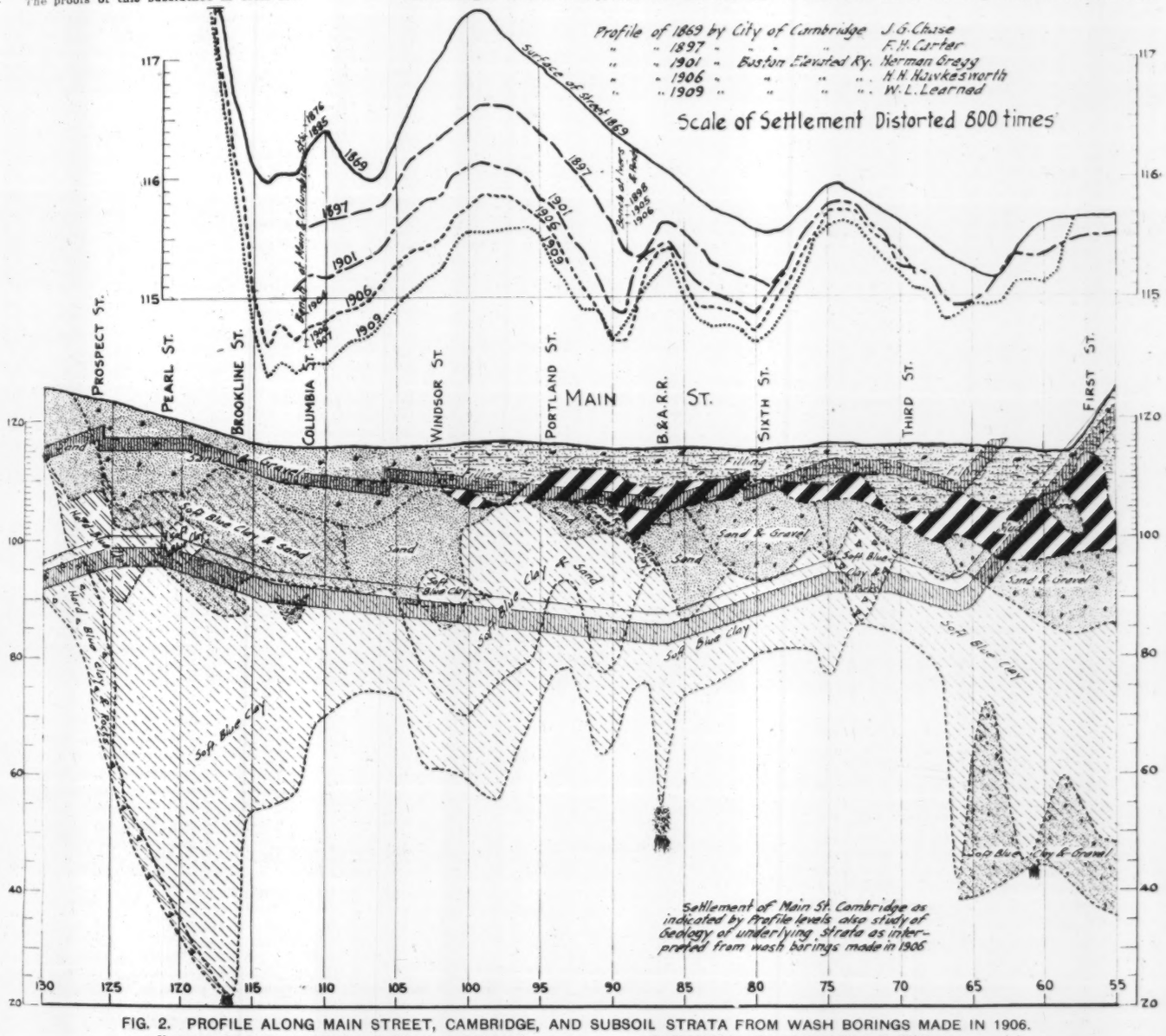

Profile of 1869 by City of Cambridge J.G.Chase
" " 1897 " " " " F.H.Carter
" " 1901 " Boston Elevated Ry. Herman Gregg
" " 1906 " " " " H.H.Hawkesworth
" " 1909 " " " " W.L.Learned
Scale of Settlement Distorted 800 times
Surface of Street 1869
1869
1897
1901
1906
1909
PROSPECT ST.
PEARL ST.
BROOKLINE ST.
COLUMBIA ST.
WINDSOR ST.
PORTLAND ST.
MAIN ST.
B&A.R.R.
SIXTH ST.
THIRD ST.
FIRST ST.
Filling
Sand
Sand & Gravel
Soft Blue Clay
Soft Blue Clay & Sand
Soft Blue Clay & Gravel
Settlement of Main St. Cambridge as indicated by Profile levels also study of Geology of underlying Strata as interpreted from wash borings made in 1906.

FIG. 2. PROFILE ALONG MAIN STREET, CAMBRIDGE, AND SUBSOIL STRATA FROM WASH BORINGS MADE IN 1906.

Upper profiles are to vertical scale 800 times horizontal scale.
Main profile is to vertical scale 40 times horizontal scale.
Profile 1869 by City of Cambridge, J. G. Chase.
Profile 1897 by City of Cambridge, F. H. Carter.
Profile 1901 by Boston, El. Ry., H. Gregg.
Profile 1906 by Boston El. Ry., H. H. Hawkesworth.
Profile 1909 by Boston El. Ry., W. L. Learned.

theory the writer is indebted. The writer also desires to acknowledge his indebtedness to valuable suggestions from Mr. R. B. Rand.

The solution of the problem of longitudinal reinforcement defies rigorous demonstration. Aside from the importance of the reinforcement in regard to stresses due to settlement, its use in "preventing" cracks was held to be very essential to avoid leakage of groundwater, which in some cases very nearly enveloped the arch section. The prevention of cracks due to contraction of the cement in setting, or to temperature changes, the possible opening of these cracks still further due to the subsidence of the district, the probable amount of groundwater and the waterproof covering, all were so closely allied

TABLE I.—ELEVATIONS AND SETTLEMENT OF BENCH-MARKS IN CAMBRIDGE.
(Compiled from City Engineers' Notebooks.)

Date.	Main St. and Mass. Ave., Orne's Cor.	Main St. cor. Columbia St., Stone Bound.	Mass. Ave., Moliers Bldg.	Odd Fellows' Bldg., Mass. Ave. opp. Norfolk St.	School St. cor. Windsor St., School House	Washington St. and Columbia St., Swedish Church.	Mason and Hamlins Broadway at Burleigh St.	Closes' B'way and Windsor St.	Main St. and Albany, Ivers & Pond.	Met. Store, Ware Ho., Mass. Ave.	Harvard Bridge Abt. Mass. Ave.	Reardon's Factory Waverly St. and Talbot St.	Brookline St. cor. Pilgrim St.
1876	.....	21.324	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1885	21.284	21.228	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1889	1889 21.084	.....	.....	.....	.....	.....	.....	.....	.....	.....	26.033	22.547	.....
1897	1897 20.711	.....	20.744	24.679	.....	.....	.....	.....	.....	21.765	25.870	.....	20.320
1898	.....	.....	.....	.....	19.712	.....	19.198	21.971	(?) 20.637	.....	.....	.....	.....
1899	.....	.....	20.621	.....	.....	.....	.....	.....	.....	.....	.....	.....	(?) 20.365
1900	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1901	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	21.118	.....	.....	(?) 20.382
1904	19.876	19.771	20.187	{ 24.243 } { 24.210 }	19.320	.....	.....	.....	.....	21.056	25.876	.....	.....
1905	.....	.....	20.171	.....	.....	21.113	19.119	21.831	(?) 20.570	21.047	.....	22.550	.....
1906	{ 19.667 } { 19.654 }	19.551	19.956	24.110	{ 19.133 } { 19.097 }	21.043	19.055	21.788	(?) 20.502	20.843	(?)	22.460	.....
1907	19.593	19.485	19.894	24.069	19.086	21.062	.....	.....	.....	20.847	25.800	.....	.....
Settlement	1.691	1.839	.859	.610	.626	.051	.143	.183	(?) .135	.918	.233	(?) .087	(?) —.062
No. of years of observation	22	31	10	9	9	2	8	8	8	10	18	17	6

as to require simultaneous consideration. To prevent cracks due to the setting of the cement in the concrete or due to changes in temperature in the ground or air, requires an amount of steel reinforcement which is not easily predetermined. Much has been written on the subject by several eminent concrete engineers, with very little agreement in regard to theory or practice.

All reinforced-concrete structures requiring longitudinal reinforcement may be divided into two classes, namely, (1) structures free to move in the direction of the expansion and contraction and (2) those either fixed by anchorage into ledge rock or other immovable material, or of such indefinite length as to be practically continuous. As to preventing cracks in structures of the first-mentioned class, local circumstances govern, depending largely upon the length of the structure and its freedom to move longitudinally; and little or no reinforcement may be necessary. On the other hand, the prevention of injurious cracks in structures of the second class, anchored firmly at the ends or of indefinite length, requires special consideration for any approach to success. It is, of course, hardly necessary to state that it is much easier to prevent cracks in a subway entirely surrounded by its earth cover than to accomplish the same results with structures wholly exposed to the elements.

In dealing with the problem two features are pretty generally agreed to by most engineers today. The first is that cracks cannot be prevented but may be so frequently distributed as to be invisible or at least very minute; and the second is the apparent absolute requirement for rods with mechanical bond. The use of deformed rods in reinforced-concrete beams for the common case of flexure may be debated by engineers for some time to come, but bond must be developed in longitudinal reinforcement to prevent injurious cracks, so that whatever cracking develops, either from shrinkage due to setting of the cement or from changes in temperature, may be as frequently distributed as possible. It is, of course, obvious that the more frequent the cracks, the less the width of the resulting cracks with the same amount of shrinkage.

Careful experiments were made by Mr. F. B. Edwards, Division Engineer of Construction, Boston Elevated Ry. Co., on concrete beams roughly about 12 ins. square in cross-section and 10 to 12 ft. long, both with and without reinforcement and free to move in all cases, but with negative results as far as the value of longitudinal reinforcement was concerned. The experimental beams shrank as setting progressed, responding roughly to changes in temperature. The room in which the experiments were conducted, however, was not much above freezing most of the time, thus retarding the process. As these experiments progressed it was suggested that the concrete beam shrank very much the same as a wooden beam and that if water were applied to the beam it would expand or stretch again toward its original dimension. It is to be regretted that the approach of subway construction prevented further experimental work along these lines. The writer is informed, however, that similar experiments have been made in Boston recently, roughly establishing the similarity of the action of a concrete beam in setting to the drying out of lumber and that water has been applied to a dry concrete beam, resulting in a tendency to assume its original dimension. The writer cannot vouch for the accuracy of the latter statement, and the "expansion," so called, resulting from the application of water to a dried concrete beam must be further demonstrated by experiment for more complete substantiation. As a partial concession to this hypothesis and for other more obvious reasons, no longitudinal reinforcement has been placed in the invert. If reinforced concrete does act similar to wood with regard to moisture, then the use of the usual waterproof covering is not only unnecessary but assists in the formation of cracks. (Still another more valid reason against the use of the waterproofing cover is the well known fact that the heat generated by the movement of the subway trains is prevented from being dissipated into the surrounding earth by

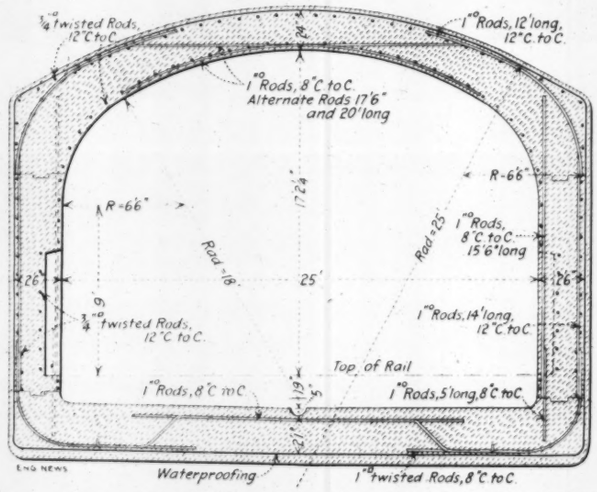

¾" twisted Rods, 12" C to C.
1" Rods, 12' long, 12" C. to C.
1" Rods, 8" C. to C. Alternate Rods 17'6" and 20' long
R=66"
R=66"
17'4"
Rad=25'
Rad=18'
25'
1" Rods, 8" C. to C. 15'6" long
26'
26'
¾" twisted Rods, 12" C to C.
1" Rods, 14' long, 12" C. to C.
Top of Rail
1" Rods, 8" C. to C.
1" Rods, 5' long, 8" C. to C.
ENG. NEWS
Waterproofing
1" twisted Rods, 8" C. to C.

FIG. 3. CROSS-SECTION OF CAMBRIDGE SUBWAY IN MAIN STREET, CAMBRIDGE, MASS.
(In filling, moist clay or wet sand; cover of 5 ft. to 7½ ft.)

TABLE II.—COMPARISON OF BENCH ELEVATIONS, CAMBRIDGE CITY ENGINEERS' LEVELS AND BOSTON ELEVATED RAILWAY CO. LEVELS.

Bench.	Elevations by City. City Base.										Elevations by B. E. Ry. Co. City Base.		
	Sept. '85	Mar. '91	Mar. '98	Aug. '99	Oct. '99	Mar. '04	Nov. '04	Mar. '05	Mar. '06	Apr. '07	Aug. '01	Jun. '06	Feb. '08
Standard near Old City Hall	30.208	30.208	30.208	30.208	30.208	30.208	30.208	30.208	30.208	30.205	.....	30.214	30.24
Hydrant Spindle, Central Sq.	.....	.....	.....	.....	.....	31.105	31.141	.....	31.108	31.117	.....	31.132	31.12
Bolt in Odd Fellows' Hall Building	.....	.....	24.679	24.586	.....	24.243	24.210	.....	24.123	24.069	.....	.....	24.05
East End Stone Step, No. 545 Mass. Ave.	.....	.....	.....	.....	.....	.....	25.439	.....	25.348	.....	.....	.....	25.27
Southwest cor. Step, No. 599 Mass. Ave.	25.236	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Stone Bound at Orne's Corner	21.284	21.084	.....	.....	.....	.....	.....	.....	19.667	19.593	.....	.....	19.54
Stone Bound cor. Main and Columbia Sts.	.....	.....	.....	.....	.....	19.771	.....	.....	19.554	19.485	.....	.....	19.44
Bolt in Moller Building	.....	.....	20.744	20.621	.....	20.171	.....	.....	19.956	19.894	20.425	19.994	19.84
Buttress Entrance W. M. Church, Columbia St.	.....	.....	.....	.....	.....	.....	.....	.....	20.665	.....	.....	.....	20.62
Bolt in Boardman School, Windsor St.	.....	.....	19.707	19.611	19.609	19.320	.....	.....	19.113	19.086	.....	.....	19.06
Bolt in Building cor. Main and Portland Sts.	.....	.....	.....	21.962	.....	.....	.....	.....	21.624	.....	.....	.....	21.57
Stone Bound cor. Main and Portland Sts.	21.488	.....	.....	.....	.....	.....	.....	.....	.....	.....	21.031	20.804	20.75
Hydrant Spindle cor. Main and Albany Sts.	.....	.....	22.847	.....	.....	.....	.....	22.271	19.571	.....	.....	.....	*22.14
Bolt in Ivers & Pond Factory	.....	.....	20.637	20.534	.....	.....	.....	20.672	20.502	.....	.....	.....	.....

*Probably reset in the interval.

the non-conducting material used in its composition.)

If one of the plain concrete beams and one of the reinforced-concrete beams had been firmly anchored at each end in the above experiments, the writer believes that the value of the longitudinal reinforcement would have been demonstrated beyond peradventure of doubt.

Before any mathematical theory had been undertaken or any experiments made to demonstrate the amount of reinforcement necessary, careful examinations were made of several existing large and important reinforced-concrete structures with a known per cent. of steel reinforcement admittedly placed to prevent or distribute shrinkage or temperature cracks. These examinations resulted in the selection of the nominal value of 0.2% of steel in each face of the structure for walls 24 ins. thick and less, and a constant amount for thicker walls. A theory was later devised by the Consulting Engineers, Messrs. Worcester and Mills, and recently published in the revised edition of Taylor and Thompson's "Concrete Plain and Reinforced," to prove that certain percentages of steel would distribute cracks of given maximum not more nor less than certain acceptable distances apart. Strangely enough, the theory established the validity of the previous assumption regarding the necessary amount of steel to prevent or distribute the cracks.

The effect of the progressive settlement of the territory in which the subway was built, on the subway structure itself, was carefully considered from several different standpoints. As has been mentioned, probable future profiles were predicted and drawn from the observations made in past years and the effect on the subway drainage system carefully considered. Studies were made looking to the use of very long piles with a view to holding up the subway from bed rock, but it has not been proven that the bed rock itself is not going down at this point. Assuming that the rock is immovable, the expediency of holding the subway at grade at the expense of all other structures seemed untenable.

The result of all the studies with regard to providing for the effect of the settlement of the district on the subway structure, was to assume that the provision made for the prevention of shrinkage and temperature cracks would provide for stresses and strains due to the settlement.

Cracks in the structure due to the settlement can arise only from local differences in the settlement, a feature unobserved thus far and apparently not probable in the future. It is probable that the subway as designed and built will accommodate itself to the sinking without any visible effect on the structure itself except changes in grade.

It may be of interest to note that somewhat extensive observations have been made on the few moderately high brick buildings in the territory to discover if any were out of plumb, that is, leaning towards the center or maximum point of settlement, resulting in the determination of the fact that as many leaned half an inch (more or less) one way as others leaned in the other direction; or in other words, there was no deviation from the plumb line except such as might be expected from inaccuracies in masonry construction, which are, as is well known, generally very small.

THE VARYING WEIGHTS OF FREIGHT CARS, that is, the varying weight of any car at different periods of its life, has been discussed at a meeting of the Association of Transportation and Car Accounting Officers, in connection with the necessity of periodically re-weighing cars and stenciling the weights in them. The following figures given by Mr. T. R. Kearney, of the Baltimore & Ohio Ry., show the average decrease in weight of large lots of steel cars weighed on that road:

Period since previous weighing.	Ave. decrease per car. Steel hopper cars, lbs.	Steel gondola cars, lbs.
1 year	702	523
2 years	1,052	592
3 years	1,220	878
4 years	1,242	830
5 years and over	1,459	959

Valuation of the Track of the Detroit Street Railway System.

The recent report of Mr. E. T. Barcroft, M. Am. Soc. C. E., on the valuation of the property of the Detroit United Ry. Co., which was abstracted in our issue of Aug. 25, goes into considerable detail as to the track construction. It presents 194 estimates of cost for track of different types and in different locations. Two examples of these estimates are given in Table I. The special work, yard tracks, etc., are valued separately.

The prices used in the track valuation are given in Table II. The steel ties are light and shallow in some cases, and in others they are simply bars (on edge) or angles. These two latter serve rather as tie-rods than as ties, especially as the rails are supported continuously by the concrete in which they are embedded to about the middle of the web. The concrete base is of various forms: in some cases it is a bed of uniform thickness; in others it is increased in depth more or less under the rails (or under both rails and ties), and in still others it consists of a separate stringer under each rail, with wooden ties embedded in the stringers and stone filling under and between them.

The track includes 21 types of rail sections, which may be classified as follows:

A. T. Rail; 6 sections, from 2⅞-in. 25-lb. to 4⅝-in. 70-lb.	4.51
B. T.-Girder Rails; 6-in. 72-lb., 7-in. 70-lb. and 91-lb.	11.59
C. Tram-Girder Rail; 4½-in. 66½-lb., 6-in. 78-lb. and 82-lb.	0.86
D. Grooved Girder Rail; 6-in. 77-lb. to 9-in. 98-lb. (with 117.92 miles of 7-in. 85-lb. and 9-in. 98-lb.)	143.92
	160.88

We quote from the report as follows:

The tracks of the company, like all its other property, have been valued on an estimate of the cost of material and labor required to reproduce them to-day. The track has been divided into different classes of construction, classifying it by the types of rails, the methods of construction and the different kinds of ties. There are 21 types of rails in use, 95 forms of track construction and 204 types of construction, including paving.

The depreciation of the trackage has been determined by taking into consideration the following factors: the condition of the rails, the weight of the rails, the substructure of ties, and the foundation and drainage. Examination was made of the rails in place and careful attention was paid to the condition of the joints, etc. The present scrap value of the rails has been determined by measurement. The flange required by the Detroit United Ry. is ⅝-in. deep, and the wearing value of the rail is the amount remaining between this height and the additional height of the rail head. The greater part of the rail has a theoretical wearing life, when new, of ⅝-in., providing its usefulness is not earlier destroyed.

The company has no records of its track construction or replacement work, and it was impossible to get information concerning existing conditions beneath the pavement without an unwarrantable amount of labor and effort. This was finally accomplished after a fashion by consultation and investigation with the company's trackmen.

The various types of rails in use are explained by the fact that the present company is a consolidation of numerous other companies, which seem to have tried almost every known possible scheme of track construction. The types of rails generally used are exceptionally poor types of grooved girder. Most of these were laid in 1895-1896 and are generally in a run-down condition. Considered from a commercial standpoint, the rails at the joints are practically destroyed beyond the possibility of repair for modern up-to-date purposes and for the future increased traffic. There also enters into consideration the element of safety and the guarding against derailments, which are of more or less frequent occurrence on this old type of rail.

The company states that it has never kept a record of the costs so that it could define when it was profitable to cease repairing track and replace it with new. Its past experiences therefore are rendered valueless. Great efforts are in evidence to save old track, when it would appear that economy should dictate replacing with an adequate and up-to-date type of rail, not only for present track conditions, but for future operating economy. The company is now doing considerable cast-welding on this old rail.

A considerable portion of the existing track has metal ties. These are absolutely worthless when the rail has to be replaced, because the old rail is 9 ins. high and the new one 7 ins., and the base is a different width, making it impossible to fasten the new rail to these old ties.

In determining the value of special work, each layout has been estimated upon the costs required for this work: ties, joints, ballast, excavation and labor for installation. All the items entering into the track are purchased directly by the company, and it would have simplified the work of the appraisal if the company had been willing to exhibit its vouchers. But this it refused to do, though such records are public property in New York, Massachusetts and Wisconsin. Each piece of special work is purchased as a layout complete. As access to vouchers was denied, prices of similar layouts in other cities were considered in reaching conclusions of prices placed upon this work in Detroit.

It was impossible to obtain from the company any record giving the life of track, special work, frogs or switches. Ties in tracks, regardless of the formation of the substructure or whether they are laid in concrete or otherwise, have a certain average life. Possibly the life of some of these ties could be extended by treatment. It would seem wise to replace practically all of the grooved rail construction as rapidly as possible, with the same amount of money now being spent in attempting to save this old worn-out track. This would be advisable because the type of cars running on most

TABLE I.—EXAMPLES OF VALUATION OF STREET RAILWAY TRACK CONSTRUCTION AT DETROIT, MICH.

(A) 7-in. 86-lb. Grooved Girder Rails on Wood Ties and 6-in. Concrete Base.	
977 cu. yds. earth and sand excavation	$341.95
977 cu. yds. earth removed from street	781.60
1,024 cu. yds. concrete for track foundation	4,608.00
25 cu. yds. sand cushion for tamping, lining and surfacing ties	37.50
1,760 W. oak ties, 6 × 8 ins., 7 ft., 10 per rail	1,320.00
135.143 tons rail, 30-ft. lengths, broken and supported joints	5,405.72
20⅞ kegs spikes, 9/16 × 5½ ins.	83.50
352 pairs 30-in. 8-hole Continuous joint plates	1,631.52
23 kegs joint bolts with nuts, 1 × 4⅜ ins.	109.25
Tracklaying	1,400.00
Total	$15,719.04
Contingencies	1,571.90
Total cost per mile	$17,290.94
(B)—9-in. 98-lb. Grooved Girder Rails on Wood Ties and 8-in. Broken Stone Base.	
1,616 cu. yds. earth and sand excavation	$565.60
82 cu. yds. earth excav. for 4-in. drain	28.70
1,692 cu. yds. earth removed from street	1,353.60
5,280 lin. ft. 4-in. drain tile	237.60
68 cu. yds. crushed stone for covering tile	132.60
779 cu. yds. crushed stone for 8-in. track foundation	1,519.05
594 cu. yds. concrete for track foundation	2,673.00
6 cu. yds. sand cushion for tamping, lining and surfacing ties	9.00
1,760 W. oak ties, 6 × 10 ins., 6 ft. 8 ins. long 10 per rail	2,076.80
154 tons rail, 30-ft. length, square and suspended joints	6,160.00
20⅞ kegs spikes, 9/16 × 5½ ins.	83.50
352 tie rods, ⅞-in. × 5 ft. 2 ins., 2 per rail 4⅜-in. nuts per rod	88.00
Tracklaying	1,400.00
352 cast-welded joints	1,056.00
Total	$17,383.45
Contingencies	1,738.34
Total cost per mile	$19,121.79

TABLE II.—PRICES USED IN THE VALUATION OF THE TRACKS OF THE DETROIT STREET RAILWAYS.

	Per cu. yd.
Excavation, earth and sand	$0.35
Earth and sand trench work	0.50
For drain tile	0.35
Haul, earth and sand	0.80
Grading, earth and sand on street	0.25
Track foundation, earth filling	0.22
Gravel	1.80
Crushed stone	1.95
Concrete	4.50
Sand cushion	1.50
Ties:	(each)
White oak, 6 × 8 ins., 7 ft.	$0.75
White oak, 5 × 11 ins., 9 ft.	1.44
White oak, 6 × 10 ins., 6 ft. 8 ins.	1.18
Cedar and pine, 6 × 8 ins., 8 ft.	0.65
Cedar and pine, 6 × 8 ins., 6 ft. 10 ins.	0.60
Angle iron, ⅜ × 2½ ins., 6 ft.	1.00
Channel iron, 7 ins., 7 ft.	2.52
Bar iron, ½ × 1½ ins., 6 ft.	0.42
Tie clips	0.22
Drain, soil tile, per lin. ft.	0.04½
Rails, per ton, T	$31.75 and 33.75
Grooved girder, plain girder and tram head	40.00
Spikes, per keg	4.00
Bolts and nuts, per keg	4.75
Tie rods, each, ⅞-in. diam., 5 ft. 2 ins.	.75
Flat, ⅜ × 1½ ins.	.07
Rail joints, per pair, 4-hole splice pls., 20 ins.	.27½ cts. to .37
Four-hole splice pls., 24 ins., 57½ cts., 27 ins.	.68¾
Four-hole splice pls., 44 ins.	1.34
Six-bolt splice pls., 26 ins., 65 cts., 28 ins.	1.07
Six-bolt splice pls., 36 ins.	.83½
10-hole., 36 ins.	.90¾ cts. and .94
12-hole, 32 ins.	1.31
Continuous, 4-hole, 20 ins.	$1.38 to 1.54½
Continuous, 4-hole, 24 ins.	1.71
Continuous, 4-hole, 26 ins.	2.53⅛
Continuous, 6-hole, 26 ins.	2.53⅛
Continuous, 8-hole, 22 ins., $4.08; 30 ins.	4.05
American	2.50
Cast-weld (each)	3.00

of it should be (and probably soon will be) replaced with heavier and more modern types.

The company requested that $12,000 be added for rail inspection at the mills. No inspections of rails have ever been made, although contemplated in the future, and consequently the item has not been included.

The track department is not in charge of a civil engineer and it is apparent that proper engineering judgment is lacking. A more thorough study and understanding of the situation, with careful supervision by properly trained engineers, would dictate a radical difference in the methods now employed, and better results could be obtained. As so much money is being spent in this department, it would seem prudent to have given more consideration to the engineering elements.

Supplementing the brief history of this valuation, which was appended to our previous article, it may be said that it seems doubtful whether this valuation will be of much practical use (quite apart from any question as to its accuracy). In the first place it lacks authority or legal standing, the committee under whose direction it was made (and which is now discharged) not being empowered to represent the city and not being recognized officially by the company. In the second place, instead of cooperation between the parties concerned there was a general antagonism between the city authorities, the company, the committee and the appraising engineer. No two of them agreed. The report itself is strongly partisan, and attacks the company's figures, records and methods. On the other hand, the company's representatives make similar attacks upon the Barcroft appraisal. As to the accuracy or merits of this appraisal we can express no opinion, and in view of the situation it does not seem worth while to give more attention to the matter. It may be necessary to have an appraisal made by a board of engineers representing or recognized by both the city and the company, and whose first business will be to arrive at a definite basis of the valuation. It may be said, however, that the present report is far from being a good example of an engineering report upon an important subject. It shows indications of hasty preparation, and presents its information in a style that does not assist in making it easy to understand, while many of the statements are obscure and ambiguous. Of course, this does not necessarily imply that the report is inaccurate, but it certainly weakens its value.

In this connection, it may be noted that a valuation of the railway and other corporate property in Michigan (but not including street railways) was made in 1900 by a state board. The work was in charge of Prof. M. E. Cooley, M. Am. Soc. C. E., of the University of Michigan, and the methods were described very fully in our issue of Dec. 20, 1900. It appears that the railways then (like the Detroit street railway in the present case) declined to allow full access to their books and records, but they cooperated in the work and furnished the information desired, recognizing the authority and legal standing of the body making the appraisal.

THE SOUTH METROPOLITAN GAS CO., which supplies with gas a large district in the southern part of London, had the selling price of its gas fixed in 1900 by Parliamentary enactment at 3s. 1d. (75 cts.) per 1,000 cu. ft., with the privilege of paying annual dividends not exceeding 4% on its capital. For each penny (2 cts.) which the company should reduce the selling price of gas, it was privileged to add 2s. 8d. to the annual dividend on each £100 of its capital. This is equivalent to adding about 1/7 of 1% to its dividend for each penny reduction in the price of gas. The company is now selling gas at 11d. below the legal rate or a net price of 53 cts. per 1,000 cu. ft. and has increased its dividends correspondingly so that its stock now pays nearly 5½%. Over one-third of the company's sales are in the poor districts of South London, where the gas is sold through slot meters. The quantity of gas sold per ton of coal delivered to the retorts was last year over 11,500 cu. ft.

Cost-Keeping in the U. S. Reclamation Service.

By D. W. MURPHY,* M. Am. Soc. C. E.

The cost data collected and compiled by the Reclamation Service are naturally divided into two classes, which may be designated as costs to contractors and costs to the United States when work is done by force account. In the latter case all equipment is owned or controlled by and all supplies, materials and labor paid for directly by the United States. The methods employed for collecting the cost data on the two classes of work are essentially the same, only slight modifications being made to suit the different organizations which are employed. The results obtained differ principally in degree of accuracy. The results on contractor's costs are subject to more or less error due to certain charges which timekeepers and others engaged in collecting data are in some cases unable to obtain. The accuracy with which it is possible to obtain contractor's costs depends to a large extent upon the willingness of the contractor to cooperate in the work and furnish figures relative to cost of equipment, executive and other charges, which the timekeepers and engineers cannot otherwise obtain.

When work is carried on by force account with an organization reporting directly to the engineer it is possible to check cost results against the actual expenditures charged to any feature of the work and in this manner guard against errors. This assumes in addition to cost keeping records a carefully kept system of accounts by means of which expenditures on each feature are separately shown. Cost keeping in connection with such a system of accounting resolves itself practically into a distribution of the total charges against a feature to the various items included in such feature.

The principal purpose of collecting cost data is to enable the engineers to determine the most economical methods for the operation of machinery and the handling of forces for the prosecution of work under construction and to facilitate intelligent analysis and estimates of work to be undertaken. Where work is being done by contract, cost data are relied upon to furnish information to the engineer relative to the contractor's ability to complete his contract, in addition to supplying unit costs to be used in making estimates and in determining the reasonableness of bids for similar work. In addition to the above reasons for the collection of cost data, which it is believed are more than sufficient to justify the expenditures involved, such data are regarded as having a further value to the Service through the information it furnishes to the engineers relative to the cost of work under the different conditions which prevail on the various projects under construction. In this connection consideration has been given to the opinion frequently expressed in discussions of the subject that cost data are of small value except to the person who collects them, and it is believed that in some cases this may be true, but there are good reasons for such conclusion. It must be admitted that mere cost figures are of little value without information relative to organization, methods employed, location, labor, climatic and other conditions which tend to influence the cost of the work. The value of the data also depends in a large degree upon the experience and judgment of the person using the data and upon the ability gained through such experience to judge of the effects of changed conditions upon costs. When conditions surrounding the work are fully described it is believed that cost figures can be used to advantage by other engineers in the preparation of estimates and the prosecution of other similar work. In the Reclamation Service, where large amounts of the same or similar kinds of work are being carried on in different sections of the country, such for example as the construction of canals and embankments and the building of concrete and other structures, conditions are exceptionally favorable for making use of such figures.

*Engineer in Charge Washington Office Engineering, U. S. Reclamation Service, Washington, D. C.

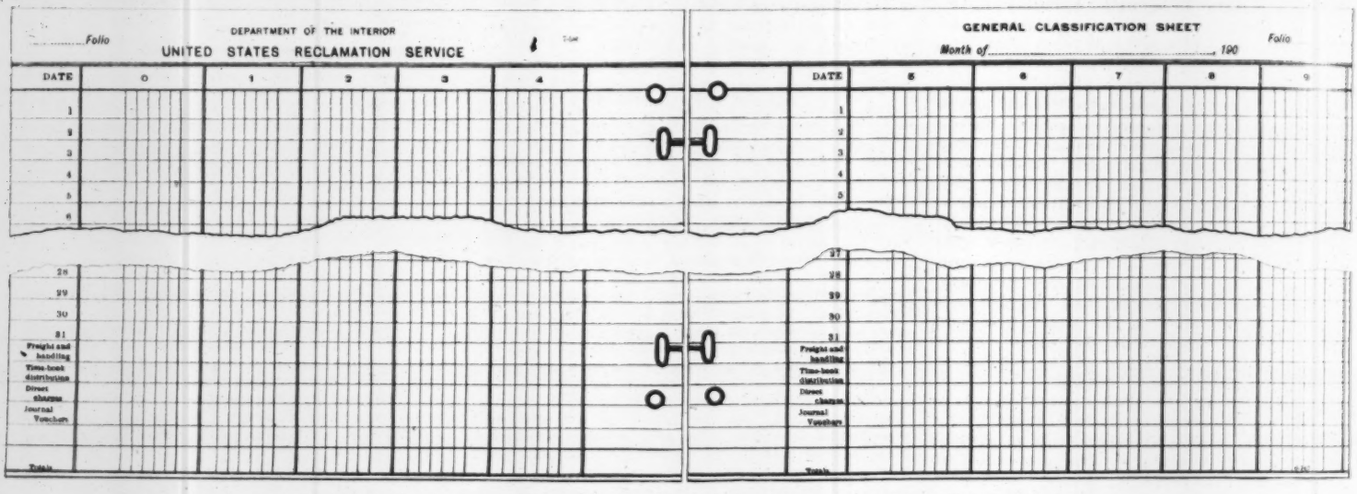


FIG. 1. GENERAL CLASSIFICATION BOOK FOR COST DATA, U. S. RECLAMATION SERVICE.
(Standard size of page, 8 x 10½ ins.)

Subdivision of Costs.

In order to obtain uniformity in accounting and cost keeping the cost of an item or feature of the work is subdivided under the following general headings: (1) interest on investment; (2) preparatory expense; (3) plant depreciation; (4) executive; (5) labor; (6) materials; (7) supplies. The charges which are classed under each of these subdivisions are as follows:

(1) INTEREST ON INVESTMENT. — All charges for insurance, and bond premium and interest on the cash capital required.

(2) PREPARATORY EXPENSE.—All charges for the cost of roads, drainage of camps, delivery and installation of plant and other expenses involved before actual construction work begins.

(3) PLANT DEPRECIATION.—All charges for repairs and depreciation of tools, machinery, buildings and use thereof.

(4) EXECUTIVE.—All charges for superintendents, foremen, timekeepers, engineers, rodmen, clerks, watchmen and other general administrative expenses.

(5) LABOR.—All charges for hire of teams and for skilled and common labor not included in "Executive."

(6) MATERIALS. — All charges, including freight, for expendable property furnished by the contractor and entering into construction and remaining a part thereof.

(7) SUPPLIES.—All charges, including freight, for expendable property used in construction work and wholly consumed therein; fuel, etc.

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

7-530 Monthly cost and progress summary No.....

.....Project, Month of 191

Contract No. Contractor

Specifications No. Schedule No. Date of contract

Original estimate			Unit bid	Quantity this month	Quantity to date	Contractor's total	
Kind of work	Unit	Quantity				Cost	Earnings
						$	$
Plant, interest and preparatory expense							

Average force employed during the month

	Men	Horses and mules
By the United States		
By the contractor		

Work begun Per cent of work done

Time for completion Per cent of time elapsed

Totals	
U. S. general expense	
U. S. engineering	
U. S. material	
Total U. S. cost	

Approved: Engineer

Correct as to U. S. cost: Bookkeeper

Correct as to contractor's cost: Cost keeper

FIG. 2. MONTHLY COST AND PROGRESS REPORT.
(Standard size, 8 x 10½ ins.)

plosives, lubricants and freight thereon; illumination, repairs, etc.

For most classes of work, such for example as concreting, rockwork, etc., this classification is carried still further in order to provide for an analysis of the costs of the various items. For example, the cost of materials under concrete would show separately the costs of cement, sand, and gravel or broken stone.

Upon the commencement of a piece of work a classification schedule is prepared of the various items of work. In the case of contract work the items taken are those upon which unit prices are fixed in the contract schedule. For force account work the features are similarly divided into items upon which it is possible to determine unit costs.

A number system of classification is used, each item of the schedule and each subdivision under that item being assigned an account number. For example, under concrete work the following numbers might be used:

Concrete:
50. Interest.
51. Preparatory.
52. Plant depreciation.
53. Superintendents and foremen.
54. Labor, building forms.
55. Labor, mixing concrete.
56. Labor, placing concrete.
57. Labor, finishing concrete.
58. Materials, cement.
59. Materials, sand.
60. Materials, gravel or broken stone.
61. Supplies, fuel.
62. Supplies, lumber for forms.
63. Supplies, oil, waste, etc.

Timekeepers.

The timekeeper whose duty it is to collect the cost data is required to visit all construction work one or more times each day and record the number of men and teams employed, rates of pay, equipment, material and supplies used. These data are collected and recorded in the field by means of the time and material distribution system. In the time book several pages are devoted to the record of each item and entries are made under appropriate heads to facilitate the distribution to the proper accounts of executive, labor, and U. S. engineering charges. In the material book charges are made against each item under the headings of plant depreciation, materials and supplies furnished either by the contractor or the United States. This is further supplemented by descriptions of the work being done, machinery used, labor and weather conditions, location, proximity to railroad or other transportation facilities, and other matters which tend to influence the rate of progress or cost of the work. Rates of pay, for men and teams, expense of equipment and cost of materials and supplies used in contract work can usually be obtained from the contractor, and when not so furnished have to be assumed at market rates. In the case of stock owned by the contractor the ordinary practice is to charge it at prevailing market prices. Certain charges, such as interest, preparatory expenses, and depreciation on machinery, other than cost of repairs, are not entered daily but carried forward until the completion of the work when they are distributed to the various items.

Classification Book.

For convenience in assembling the data collected a classification book, form 7-580 (Fig. 1), is provided in which the timekeeper enters at the close of each day the results of that day from his time and material book. The classification book is provided with ten columns, numbered from 0 to 9 consecutively. The last figure of the account number under which the charge is made is represented by the number of the column while the first figure of this number is entered as the folio number at the top of the page. Column 4 under folio No. 5 would be number 54, in which would be entered all charges for labor on concrete forms in the example heretofore given. Each item of cost is entered in its proper column so as to show the particular piece of work to which it is charged and on the proper line representing the date when such charge is made. Space at the foot of each column is provided for such items as freight, interest and similar charges, to be added at the end of the month or on completion of the work as the information becomes available.

Monthly Cost and Progress Report.

At the end of each month a report on form 7-530 (Fig. 2) for each principal construction contract is forwarded by the project office through the Supervising Engineer to the Washington office. This report is made up principally from the following sources: (1) the engineer's estimate of the quantity of work done; (2) the contractor's costs for each item as shown by the classification book; (3) the contractor's earnings at the unit prices for the various items; (4) the costs of engineering and materials furnished by

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

7-602 PROJECT MONTHLY COST REPORT

.....Project.

Feature Month of , 191

Account No.	CLASSIFICATION	THIS MONTH		TOTAL TO DATE	
		Amount	Unit Cost	Amount	Unit Cost
	Total,				

Work commenced | Percentage complete | Estimated unit total cost | Lowest total bid received $ | Lowest unit bid received

CLASS OF WORK	UNIT OF MEASURE	THIS MONTH		TOTAL TO DATE		REMARKS
		Quantity	Unit Cost	Quantity	Unit Cost	Materials:
						Rock:
						Labor:
						Equipment:
						Weather:
						Miscellaneous:

CORRECT: Bookkeeper

6—802 Additional remarks may be written on the back hereof.

FIG. 3. PROJECT MONTHLY COST REPORTS.
(Standard size, 8 x 10½ ins.)

the United States. In addition to the principal data relative to costs and quantity of work done, the report shows the bid of the contractor, average force employed, profits to date, per cent. of work done, time elapsed, etc.

Instructions for the preparation of this report, which are printed on the reverse side of the form, are as follows:

A report on this form (7-530) should be transmitted to the Director's office for each formal or informal construction contract at the close of each month.

It is desired to know the amount of work accomplished during the month and to date and the cost to the contractor and the United States, also the per cent. of progress made and time elapsed. Additional essential data should be reported above under "Remarks."

The entire schedule of the contract should be written out each month, thus showing the amount and character of the work remaining to be done.

The estimated cost of plant, interest and preparatory expense should be entered each month in the column for contractor's total cost until it can be apportioned to the various items of the contract upon their completion. If at any time a part only of these expenses may be so apportioned this may be done and the remainder left for later apportionment.

The "Total U. S. cost" should agree with the "Total to date" of the same feature or contract account as reported on form 7-602, Project Monthly Cost Report.

It is important that all of the information called for be furnished in the appropriate places each month for the information of the Director.

This report should be checked as to its correctness and signed by representatives of both the engineering and accounting divisions.

Project Monthly Cost Reports.

Reports on form 7-602 (Fig. 3) are also forwarded to the Washington office for each active feature on the cost ledger. This report is prepared from the project accounts and shows the total amount of expenditures, on each feature, distributed to the various items. It furnishes the basis for the preparation of cost statements for work done by force account. The character of this report and an outline of the information it contains is shown by the instructions printed on the back of the form as follows:

This report should be made out at the end of the month, after the books have been closed, and sent to the office of the Director not later than the 15th of the month following.

ACTIVE FEATURES.—One report should cover every live or active Cost Ledger feature.

Fill in the account number, classification, amount under "This month" and under "Total to date." Total the columns showing costs for the current month and to date, and fill in the blanks at the bottom of the report.

When the report covers operations the results of which are measurable in uniform units, as excavation, embankment, paving, laying concrete, masonry, boring tunnel, manufacture of cement, etc., fill in unit-cost columns, otherwise these columns may be disregarded. If detailed reports of unit costs, other than on this form are prepared and submitted to the office of the Director for this feature, write in the column for unit costs: "See separate report of unit costs herewith."

INACTIVE FEATURES.—All features that receive no charges during the current month should be listed on this form, with amount in "Total to date" column filled in, using one line for a feature, so that the total of these reports for any month can be verified by the debits to Cost Ledger reported in the balance sheet, both as to current month's business and total to date. Do not report inactive features by account numbers, but by totals only.

COMPLETED FEATURES.—When any feature is 100 per cent. complete unit costs should be reported in detail, if the product can be measured in units.

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

7-548. Final item cost analysis

....., 19

Contract No. ..... Contracto .....

Specifications No. ..... Project ..... Date of contract .....

Final cost analysis of ..... Item No. ..... Quantity .....

	Distribution		Total		Unit	%	Remarks
			$		$		
1	Contractors	Interest on investment					per annum on $ ..... for ..... mos
2	Contractors	Preparatory expense					
3	Contractors	Plant depreciation					% of total plant cost of $ .....
4	Contractors	Executive					
5	Contractors	Labor					
6	Contractors	Materials					
7	Contractors	Supplies					
8	Contractors	Total contractor's cost				100	
9	United States	Total contract earnings					
10	United States	U. S. general expense					
11	United States	U. S. engineering					
12	United States	U. S. materials					
13	United States	U. S. miscellaneous					
14	United States	Total U. S. cost				100	as per Form 7-602 to 19
15		Total actual cost					
16		Estimated cost					Estimated quantity

Work begun ..... 19 ..... Work completed 19

Approved: ..... Engineer

Correct as to total U. S. cost: ..... Bookkeeper

Correct as to contractor's cost: ..... Cost keeper

(over)

FIG. 4. FINAL ITEM COST ANALYSIS.
(Standard size, 8 × 10½ ins.)

Final Cost Reports.

Upon the completion of a contract final cost reports thereon are prepared on forms 7-548 and 7-548a (Figs. 4 and 5) and forwarded to the Washington office. A report on form 7-548, final item cost analysis, is prepared for each item of the contract; the information given thereon is shown by the various headings on the blank form. The distribution of total contractor's cost included under headings 1 to 7 is made in accordance with the general subdivisions heretofore outlined. The other data, provided for under items 9 to 16, are defined in the printed instructions on the back of the form as follows:

9. TOTAL CONTRACT EARNINGS.—The total amount and unit price paid the contractor, based on the amount of work done.

10. U. S. GENERAL EXPENSE.—All charges for the cost of administration not included in engineering, such as proportion of expenses of general offices and headquarters office.

11. U. S. ENGINEERING.—All charges for cost of supervision and inspection by the United States from date of beginning construction.

12. U. S. MATERIALS.—All charges for materials furnished by the United States.

13. U. S. MISCELLANEOUS.—All charges of a miscellaneous nature chargeable to this item of contract which can not be classified as engineering or administrative expense.

14. TOTAL U. S. COST.—The sum of 9, 10, 11, 12 and 13.

15. TOTAL ACTUAL COST.—The sum of 8, 10, 11, 12 and 13.

16. ESTIMATED COST.—The estimated total and unit costs submitted by the board recommending the advertisement and construction of the work.

This report should be checked and signed by representatives of both the engineering and accounting divisions, and the sum of the various total costs of all items of a given contract together with any extra work involved should agree with the amounts shown in the final report for the same contract on form 7-530.

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

7-548a. Feature and contract final cost analysis

..... 19 .....

..... Feature ..... Project .....

Kind of Work	Unit	Quantity	Contractor's cost		Contractor's earnings		United States cost		Actual cost	
			Total	Unit	Total	Unit	Total	Unit	Total	Unit
			$	$	$	$	$	$	$	$
Extra work										
Preliminary expense										
Gross cost										
Deductions										
Net cost as per Form 7-602 to 19										

Specifications No. ..... Contr. No. ..... Contractor ..... Work began ..... 19 ..... Finished ..... 19 .....

Location: Distance from R. R., etc. .....

Description .....

Contractor's plant .....

Conditions .....

Average force: Contractor, ... men, ... horses; United States, ... men ..... horses

Wages per day: Foreman, $ ..... carpenters, $ ..... masons, $ ..... hoist engineers, $ ..... steam shovel engineers, $ .....
cranesmen, $ ..... drillmen, $ ..... laborers, $ ..... teams with drivers, $ .....

Cost to United States: Engineering, $ ..... ; cement, $ ..... ; other material, $ ..... ; general expense, $ .....

FIG. 5. FEATURE AND CONTRACT FINAL COST ANALYSIS.
(Standard size, 8 × 10½ ins.)

The report on form 7-548a, feature and contract final cost analysis, is made to cover an entire contract or a principal feature of a contract such as would be represented by a separate schedule. It is prepared from the information contained in the various reports on form 7-548 and is practically a summary of these items for a contract or large feature of a contract. It is the purpose of this report to bring together in concise form all cost data relating to a particular

feature of contract work. The cost of making preliminary surveys and other expenses prior to the beginning of construction work is entered under "Preliminary expense." U. S. Engineering and general expense are included in the various items under "United States cost" and "Actual cost." Descriptions of the work and conditions affecting it are entered in the blanks provided; the reverse side of the form also provides space for additional remarks relative to the work.

This report is required to be certified by the cost keeper as to the correctness of contractor's costs, by the bookkeeper as to the correctness of U. S. costs and to be approved by the engineer in charge.

Cost Data Cards.

For the convenience of the engineers of the service, the final cost reports on form 7-548a for contract work and the summaries prepared from form 7-602 for force-account work, are edited in the Washington office and typewritten in uniform style on sheets 8 × 10½ ins. These sheets

EMBANKMENT ---------- PROJECT

Kind of work	Unit	Quantity	Contractor's cost Total	Unit	Contractor's earnings Total	Unit	United States cost Total	Unit	Actual cost Total	Unit
Embankment:										
Earth & Gravel	cy.	671,915	141,917.	.211	161,259.60	.24	167,741.60	.256	148,399.	.22
Gravel facing	"	254,720	63,035	.247	89,152.00	.35	91,856.00	.36	65,739.	.258
Cutoff trench Cl.1	"	31,193	4,709	.151	4,678.95	.15	5,126.95	.164	5,157.	.165
" " Cl. 2	"	21,780	6,371. 2	.292	6,525.00	.30	6,897.00	.316	6,735.	.309
" " Cl. 3	"	1,628	894	.546	569.80	.35	609.80	.374	934.	.57
Outlet Works:										
Concrete	"	1,029	4,083	3.94	5,145.00	5.00	8,965.00	8.71	7,873.	7.64
Steel (reinforcing)	lbs.	37,260	1,789	.048	1,490.40	.04	1,490.40	.04	1,789.	.048
" (structural)	"	10,728	1,169	.107	429.00	.04	429.00	.04	1,169.	.04
Extra work & mat.					240.65		240.65			
Cement, Frt. & Stg.					440.64		440.64			
Totals			225,939.		269,931.04		283,797.04		237,795.	

Estimated value of contract 256,550.00

Spec. (Sch.6 of 7); Contr. ..... work begun Mar. '08; finished Jan. '08.

Location.—Six miles from R.R. town ..... branch R.R. built to site after constr. began.

Description.—Earth and gravel embankment 7,350 ft. long; 20 ft. wide on top; 44 ft. max. height; 3:1 slope water side; 1½:1 other side. Gravel and earth body and gravel faces. There are 3 cutoff trenches extending the length of embankment and a large drainage trench at lower toe. Outlet works consist of a concr. conduit with 3-6' dia. openings, a concrete gate tower and a steel bridge and canopy at tower. The 3x6 C.I. gates are not included in this contract.

Methods.—Earth was excavated by graders from borrow pits at each side of and extending the entire length of fill, and from two borrow pits by steam shovels located at one end of dam. Hauling was done by wagons for graders and by cars for steam shovels.

Wages.—Steam shovel engr. $150.00; oranemen $115.00; firemen, $100.00 per mo. Common labor $2.25 to $2.70 per day; grader men $2.70 per day.

Average force.—Contractor's force, 55 men and 37 teams.

Classification.—Cl. 1—Wet. that can be plowed by a 6-horse team.
Cl. 2—Indurated material that can be plowed by a 10-horse team.
Cl. 3—Indurated material requiring blasting first.

Engineering.—Cost to the United States, $10,500. Cement (1012 bbls.) cost to the U.S., $3,351.00.

Note.—Figures represent construction costs only; preliminary surveys, plans, etc. not included. Construction engineering and superintendence included in United States and actual costs.

Fig. 6. Contract Work.

SPILLWAY (RAISING) MINIDOKA ---------- MINIDOKA PROJECT

Kind of work	Unit	Quantity	Cost Unit	Cost Total	Remarks
1. Cutting notches in concrete	Piers	342	6.87	2,350.26	Work done by Force account.
2. Steel rein. and tie bars	lbs.	64,000	.029	1,830.35	Begun Sept. 17 '09, finished Dec. '09.
3. Drilling 2" holes in conc. (30")	l.ft.	3,200	.625	2,000.00	Location.—Distant 6 mi. from R.R. town of Minidoka, Idaho.
4. Conc. 1:2:4	15 mix. cy.	1,100	8.50	9,328.71	Description.—Work consists of erecting 342 conc. piers on present spillway which is over 2400 ft. long and was built under contract No. 17 in 1905 and 1906. Piers are 8 ft. high, 24 ft. wide at base, 4 ft. at top and 18" thick and spaced 7 ft. c
5. Forms for conc. (31 M ft.)	"	"	2.60	2,855.31	
6. Track, staging, etc. (*)	"	"	2.40	2,631.52	
Railing both sides 60,000 lbs.	l.ft.	2,400	1.76	4,222.97	
Walk, 3" (22 M ft.)	M ft.	29,000	40.20	1,166.97	
Flashboards, 3" x 6"				1,650.76	
Camp charge, lighting, etc.				1,000.00	
GRAND TOTAL				28,040.45	

Piers are keyed into old work and anchored by means of the ¾" vertical reinforcing rods which extend 30" into the crest of old spillway. The rods are upset on the lower end. On top of the piers a 4-ft. walk with steel railing extends the entire length of the spillway and serves as an operating platform.

Methods.—Collapsible wooden forms were used for piers - 12 to 15 piers being constructed each day and 45 forms being in use continuously. Gravel was hauled and screened by contract and cost $2.14 per cy. Mixer was 1/3 yd. "Chicago" mounted with gas engine on trucks and was moved along the downstream side of the spillway. Water was within two feet of the crest of spillway during construction. Drilling for reinforcement was done by hand and the 2" holes 30" long were enlarged to 2½" for 6" at lower end. A test of the ¾" upset bars grouted into these holes caused them to break instead of pulling out of concrete.

Conditions.—Work had to be done on downstream side of spillway, on the rough lava ridge (the irregularity of which the spillway follows) and a road had to be built over the entire 2400 ft. for the supply teams. As the old spillway was 2 to 15 ft. high, scaffolding had to be used and moved forward the entire distance.

Average force. ..... 50 men, 15 being carpenters.

Wages.—Carpenters 3.20, laborers 2.25, team and driver 4.50 per day.

Remarks.—Water raised 5 ft. by flashboards, 60,000 acre-feet additional storage at .47.

ANALYSIS OF COST

Subdivision	(1)	(2)	(3)	(4)	(5)	(6)
Labor	2,272.80	1,974.26	567.44	2,876.24	1,849.42	2,009.09
Material			2,210.37	6,183.16	997.41	434.69
Supplies	3.39	5.03	10.47	122.15		187.74
Tools & equip.	74.07	20.71	42.07	147.18	8.43	
TOTALS	2,350.26	1,000.00	2,830.35	9,328.71	2,855.31	2,631.52
	6.87	2.924	.828	2.73	.835	.77

Note.—Figures represent construction costs only; preliminary surveys, plans, etc. not included.

Fig. 7. Force Account Work.

FIGS. 6 AND 7. COST CARDS, U. S. RECLAMATION SERVICE.

are then reproduced by photolithography, with a reduction of about one-half and printed on cards 4½ × 6½ ins. (Figs. 6 and 7). For convenience in indexing the cards, the name of the feature and the project to which it belongs are placed at the top of the card. Below the cost figures are given descriptive data necessary to an understanding of the work and the methods and conditions under which it was accomplished.

Fire Hose Tests at the Underwriters' Laboratories, Chicago, Ill.*

By WM. H. MERRILL.

As showing some of the work we [Underwriters' Laboratories] are doing, I will place on record with you our conclusions reached as a result of tests of sample lengths of new cotton rubber-lined public department fire hose sent in from lots recently delivered to a number of departments in different sections of the country. The tests were made under specifications referred to as a "Minimum Standard" by the manufacturers engaged in this industry. We are prepared to admit that a higher standard for this material should be set.

The results of extended tests and examinations of 16 different brands of fire hose received from fire departments in the far West, the central West and the East, show important deficiencies in all, and clearly indicate that, almost without exception, these are of such inferior quality that they should not be accepted for use in a public fire department. While the brands investigated are by no means equally poor in quality, there is hardly a feature relating to the materials employed or the details of manufacture which does not merit criticism with more or less frequency, considering the tests as a whole.

Rubber Lining.

The most important defect and the one most commonly present relates to the quality of the rubber linings employed. Extended analysis shows that the percentage of gum used varies from about 26 to 52%, and that it is almost universally of inferior quality. In only two cases could any claim for high-grade rubber have been justified and these did not fully meet the minimum standard considered essential for this important class of service. Compounds which may contain pure gum even of high grade are often admixed with reclaimed rubber or shoddy and mineral oils, and low-grade gums are commonly employed.

The following summary of the results of the physical tests of the rubber linings, when compared with the minimum standard given just preceding the tables, will serve to indicate the general quality of the linings used in the hose tested. The general averages given in the tables are obtained from over 50 test samples and the averages for individual hose from four samples, the samples being cut longitudinally from the tubes in all cases.

STANDARD FOR PHYSICAL TESTS OF RUBBER LINING.

(a) Breaking strength to be not less than 900 lbs. per sq. in.

(b) Length at breaking point to be not less than 4½ times the initial length.

(c) When stretched to 4½ times its original length and held in that position for ten minutes, ten minutes after release the length not to be in excess of 2⅜ ins. where the original length between marks is 2 ins.

SUMMARY OF PHYSICAL TESTS OF RUBBER LINING.

Average tensile strength all samples	695.5 lbs.
Highest average tensile strength any hose	1,304.3 lbs.
Lowest average tensile strength any hose	199.3 lbs.
Average elongation at breaking point (all samples)	8.1 ins.
Highest average elongation at breaking point any hose	9.6 ins.
Lowest average elongation at breaking point any hose	5.8 ins.

In only six cases could the samples be stretched to 4½ times their original length without rupture and in none of these was the recovery within the limits specified ten minutes after release.

Cotton Fabric.

The defects found in the cotton fabric used in the hose tested, while important in many instances, were generally of secondary importance compared with those relating to the rubber portions of the hose. Wide variation was noted in the degree of excellence in weaving as well as in the character of the finished product. Very little, if any, long staple cotton could be identified, that most commonly employed being not more than 1 in. in length. Considerable difference in the grade of the cotton was also apparent.

Fabric was commonly employed which contained unsightly and injurious defects which by the greatest stretch of imagination could not be classified as incident to the best practical manufacturing. Some brands of hose having the best grades of rubber noted were provided with fabric which would cause doubt as to possession of machinery capable of producing a proper fabric, or which would indicate intention to furnish an inferior article. Other brands having inferior grades of rubber linings, were provided with strong, evenly woven fabric regarding which no criticism could be offered as a result of their performance in the hydrostatic pressure tests.

The following is a summary of the results relative to fabric obtained in the hydrostatic pressure tests:

BURSTING TESTS, 3-FT. SECTIONS.

	Lbs.
Average bursting pressure of all hose tested	710.9
Maximum bursting pressure of any hose tested	975.
Minimum bursting pressure of any hose tested	518.

Note.—Samples tested with hose lying straight and with pressures increased at the rate of 100 lbs. per minute. Results given in pounds per square inch.

TESTS OF FULL LENGTH SECTIONS TO 450 LBS.

In only two cases did the hose show any signs of weakness in the cotton fabric or extraordinary increase in diameters at a pressure of 450 lbs. per sq. in. In one of these the hose burst at 410 lbs. and 51 and 27 filler strands were found ruptured in the inner and outer plies, respectively, none of the warp strands being broken.

In the other case, the warp strands in the inner ply started to break at 400 lbs. and were broken quite generally in this ply at 450 lbs., and, to some extent, in the outer ply. In this case the fille s were apparently uninjured.

ELONGATION AT 300 LBS. PRESSURE.

	Ins.
Average elongation of all hose tested	48.86
Maximum elongation of any hose tested	66.62
Minimum elongation of any hose tested	21.87

Note.—The samples tested were not exactly 50 ft. in length, but did not vary from this dimension to any considerable extent.

TWIST AT 300 LBS. PRESSURE.

	Turns.
Average amount of twist for all hose tested	.84
Maximum amount of twist for any hose tested	1.50
Minimum amount of twist for any hose tested	0.

Note.—In two cases no tendency to twist was noted. Of the others, about one-half twisted in a direction tending to tighten and about one-half in a direction tending to loosen the couplings. The results are given in turns for the entire length of the hose.

WARPING AT 300 LBS. PRESSURE.

	Ins.
Average amount of warping for all hose tested	12.29
Maximum amount of warping for any hose tested	45.0
Minimum amount of warping for any hose tested	0.

Note.—In only one or two cases did the hose show any tendency to rise from the table and writhe. In several cases it was necessary to straighten the hose and place it back on the table. The maximum deflections from the original positions are given in the above and not the number of convolutions.

Cement Backing.

The defect next in importance and which was present in the hose tested to a very marked extent, relates to the character of the surface of the waterway and the influence of this on the efficiency of the hose. This appears to be a point which is almost universally neglected, but it is perhaps unnecessary to call your attention to the disadvantages of hose introducing friction losses over 50% in excess of the normal loss for hose manufactured by the best methods. Under certain conditions, excessive hydraulic friction losses may have a very important influence on the degree of protection obtainable at time of fire.

In practically all cases, and particularly where the hose was provided with hand-made lining, the cement backing was thin and insufficient to properly fill the interstices between the fillers and reduce the corrugations to a minimum. In the majority of cases, the lining was provided with a heavy backing for from 2 to 4 ft. back from the couplings and was fairly smooth in these portions, the balance of the length being badly corrugated.

In all but three cases the hydraulic friction loss was in excess of the allowable loss for good hose. In six cases the loss was excessive, amounting to over 20 lbs. per 100 ft., with 250 gals. per minute flowing and reaching a maximum of 25.7 lbs. in one case. At the higher velocities, the difference between the allowable loss and that obtained in the tests of this hose generally increases quite rapidly. The allowable loss for good hose with 250 gals. per minute flowing is 15.1 lbs. per 100 ft. of hose.

Couplings.

The tests and examinations of the couplings attached to the hose submitted show that this item is also commonly slighted, not only in regard to the quality of the castings and workmanship, but also in the attachment of the couplings to the hose.

The average weight of the couplings for 2½-in. hose

*From a paper on "The Objects of Tests and Investigations at Underwriters' Laboratories," an address delivered at the annual convention of the International Association of Fire Engineers, Syracuse, N. Y., August, 1910.

was 5 lbs. 6.73 ozs., including the expansion rings, only slightly less than the minimum weight of 5½ lbs. specified. The maximum weight for any one set of couplings was 6 lbs. 4.7 oz.; minimum, 4 lbs. 11.39 oz. In eight cases the couplings were underweight.

The castings were not analyzed, but their color indicates that the percentage of copper employed is low in the majority of cases. In nearly all, the tail pieces and expansion rings are somewhat shorter than specified in the standard, and, in some the metal was not strong enough to resist the stress of expanding the binding rings without rupture. In several cases the corrugations for binding the hose contained sharp projections due to sand left in the molds, and in one the corrugations were sharp enough to cut the hose fabric.

The machine work and finish were generally well executed, but sufficient care was not always exercised in obtaining a proper thickness of metal in all portions. In two cases, the couplings were ruptured in the bursting tests for hose, the male ends being blown off at 841 and 617 lbs. per sq. in., respectively. Examination showed that the metal was less than 1/16-in. in thickness at the point where the threaded portion joins the tail pieces—a section entirely too thin to safely withstand possible conditions of service.

In one or two cases, couplings made by different manufacturers were not interchangeable, although both were sold to the same city.

The couplings withstood the 300-lb. pressure test without leakage in only five cases, careless workmanship being generally responsible for the defects.

The most prominent defect resulting in leakage at the couplings was the absence or imperfect installation of rubber washers between the expansion rings and the tail pieces, although in one or two cases where the washers were properly installed the rings were insufficiently expanded to make a tight joint. Liberal leakage was noticeable past the tail pieces at pressures as low as 10 lbs. per sq. in. in several instances and sweating through the fabric, due to leakage around the ends of the hose, was noted at distances as far as 48 ins. back from the couplings. No leakage occurred at 450 lbs. in four out of five cases where the couplings were tight at 300 lbs. per sq. in.

The cotton fabric was doubled back in the couplings in many cases and was quite badly cut by the corrugations in one instance. The rubber linings were cut part way through by the rings in four cases.

In three cases, the couplings were not equipped with gaskets; and in three, the gaskets were loosely fitted, these being forced back into the recess in the swivel at pressures as low as 90 lbs., thus causing bad leaks between the couplings in almost every instance. This defect did not occur where the gasket was accurately fitted.

General Comments.

It has been claimed that the hose furnished is as good as municipalities are willing to pay for, and that the lower grades are sufficiently reliable for smaller cities where the service is not severe. A comparison between the prices paid and the quality of the hose furnished does not seem to bear out the first contention, for the best hose is frequently sold for the lowest prices, and hose of the poorest quality often sells at the highest prices. Then, again, hose of substantially the same quality and bearing the same distinctive manufacturers markings, sells for prices differing by wider margins than can be accounted for by any difference in locality or legitimate cost of selling.

Careful consideration of the second contention and a study of the different conditions of service in the various cities, does not indicate the necessity or propriety of using hose of inferior quality in the smaller cities, even though it may be conceded that the service is not so severe. There is even some reason for the belief that the better grades of hose are more necessary where it is infrequently used, and the service is not severe.

The results of our investigations could be given in far greater detail, but I will not burden you with these at this time. They serve to show that fire departments generally are not obtaining a proper quality of fire hose, and that there is a marked tendency to employ inferior materials and to slight all of the details of manufacture of this most important part of fire department equipment.

It is, unfortunately, a fact that it has been most distinctively "American" for municipalities to purchase materials on the representations of interested parties, and to often accept assurances as to their quality without proper investigation as to the facts in the case.

The statement is frequently made that the manufacturer knows more about hose than do those who purchase it. Up to a certain point this may be true, but there should be no mystery about what constitutes a proper quality of hose for use in public fire departments and no question about its being received when payed for.

The strength of hose lies in the cotton fabric and past experience in actual service as well as good practice in the manufacture of fabrics has clearly defined what this should be. The life of hose lies in the rubber lining, and there is now sufficient evidence available as to the rubber compounds giving the best practicable service to establish definite values for materials of known quality, and remove all doubt as to their reliability and durability.

I may, perhaps, be pardoned for expressing the opinion that the present general practice of purchasing hose by brand or trade name, under a short-term guarantee, and the failure to use and enforce adequate specifications, are chiefly responsible for the present unsatisfactory condition of fire department hose.

Under the guarantee system, the hose dealer need only figure on a quality of hose just about good enough to last during the term of the guarantee, and, should the competition be severe, a few replacements during the term could probably be made at less cost than to furnish hose which would not have to be replaced. The guarantee serves to conceal the real merit of the product. Behind it the quality of materials and workmanship may be manipulated with but little regard for the interests of the purchaser. It covers only defects of manufacture, and the more important matter of damage resulting from the failure of hose is, of course, not comprehended. The term of the guarantee has been gradually reduced, and three years is now commonly accepted.

While there is undoubtedly much to be said on the other side of the question, relative to abuses of the guarantee and regarding conditions which may have led to the present unsatisfactory state of affairs, the following remedy, although involving more direct responsibility on the part of fire departments or municipal authorities, would undoubtedly result in securing a proper fire hose. The remedy is as follows:

(1) Totally abolish all forms of guarantees.
(2) Adopt standard specifications properly covering each essential item entering into the manufacture of fire hose.
(3) Secure impartial, thorough enforcement of such specifications before acceptance of the hose.

Fire hose is certainly of sufficient importance in the economy of things to warrant an equal position with, if not precedence over, other industries in securing a proper grade of rubber. The natural increase in cost occasioned by the use of better materials will be more than offset by the increase in the durability of the hose, and, most important of all, by the increased security against possible losses compared to which the cost of hose is negligible.

Operating and Maintenance Costs of Locomotive Coal and Ash Handling Stations.

By HENRY J. EDSALL.*

The writer had occasion recently to collect the data in regard to the cost of operating and maintaining various types of stations for coaling locomotives and for handling the ashes from locomotives. He found these data rather scarce and hard to obtain. Where reliable records were kept, many important items were apt to be omitted so that the results lacked uniformity to such a degree that few comparisons of any value could be made. It would seem that the possibility of making such comparison is of sufficient importance to the engineering and operating staffs of railways to warrant the adoption of some uniform method of keeping costs and tabulating results. To designers and builders of coaling stations and coal and ashes handling machinery, such a tabulation of results is of vital importance as a guide to more efficient design and to the further improvement of the mechanical equipment.

Data Required.

In order to make a satisfactory comparison of operating costs, it is necessary to have the following data:

(1) Number of men employed at the station, and hours and wages of each. The amount of time chargeable to each of the several operations of handling coal and ashes should be given, and the cost of superintendence should be properly divided between the coal handling and the ashes handling.

(2) Where a mechanical equipment is used, the cost of the labor, fuel and other supplies which go to make up the cost of power, should be given, or where the power is supplied from some central station, the total cost of power should be included, and this should be properly divided to show how much is chargeable to handling coal and how much to handling ashes.

*Mechanical Engineer, Link Belt Co., Philadelphia, Pa.

TABLE I.—LABOR COSTS FOR HANDLING COAL AT LOCOMOTIVE COALING STATIONS.

Station.	Av. No. locomotives per day.	Men employed.	Cost per day.	Av. tons per day.	Cost per ton
No. 1	120	1 foreman, $55 per month	$1.80	....	....
		5 men to unload cars 10 hrs. per day	7.00	....	....
		2 coal dumpers, 12 hrs. per day	2.80	....	....
		Total	$11.60	550	$0.021
No. 2	120	1 machinery man 10 hrs. per day	$1.50	....	....
		5 men to unload cars 12 hrs. per day	6.50	....	....
		2 coal dumpers, 12 hrs. per day	2.60	....	....
		Total	$10.60	550	$0.019
No. 3	76	½ foreman's time at $66 per month	$1.10	....	....
		1 machinery man at $55 per month	1.80	....	....
		3 men to unload cars 10 hrs. per day	4.50	....	....
		2 coal dumpers, 11 hrs. per day	3.30	....	....
		Total	$10.70	500	$0.021
No. 4*		½ foreman's time at $66 per month	$1.10	....	....
		1 engineer at $55 per month	1.80	....	....
		½ fireman's time, 11 hrs. per day	0.83	....	....
		2 machinery men, 11 hrs. per day	3.30	....	....
		3 men to unload cars	4.95	....	....
		2 coal dumpers	3.30	....	....
		Total	$15.28	625	$0.024

*Wages estimated from those paid at previous stations.

TABLE II.—LABOR COSTS FOR HANDLING ASHES AT LOCOMOTIVE COALING STATIONS.

Station.	Av. No. locomotives per day.	Men employed.	Cost per day.	Av. No. cu. yds. per day.	Average cost per cu. yd. pits to pocket.	Av. cost cu. yd. including cleaning fire-boxes.
No. 1:* Amt. ashes assumed at 40 cu. ft. per loco. Wages assumed.	60	5 day and 5 night men to operate mach'y, feed ashes to same and clean fire boxes	$15.00	88	.....	$0.170
No. 2:† Assumed that three 25-ton coal cars = 120 cu. yds.	75	½ of foreman's time at $66 per month	1.10	...	.....	.....
		1 day and 1 night man to operate gates of ash hoppers	3.30	...	.....	.....
			$4.40	120	$0.037	.....
		6 day and 6 night fire box cleaners, 11 hrs. per day..	19.80	...	.....	.....
			$24.20	...	.....	$0.202
No. 3:† Assumed that six 25-ton coal cars = 240 cu. yds.		½ of foreman's time at $66 per month	$1.10	...	.....	.....
		1 day and 1 night machinery man	3.30	...	.....	.....
		1 day and 1 night man to operate gates of hoppers..	3.30	...	.....	.....
			$7.70	240	$0.032	.....
		10 day and 10 night fire box cleaners	33.00	...	.....	.....
			$40.70	...	.....	$0.169

*At Station No. 1, ashes are deposited in pits about 50 ft. long and scraped to either of two conveyors. Machinery operated 1½ to 3 hrs. per day, usually only morning and evening.
†At Stations No. 2 and No. 3, ashes are deposited in hopper and fed directly to conveyors, which have to be operated each time the hoppers become filled up.

TABLE III.—COST OF OPERATION AND MAINTENANCE OF GRAVITY-DISCHARGE ELEVATORS HANDLING COAL AT LOCOMOTIVE COALING STATIONS.

Station.	No. tons handled.	Operation, cost per ton.	Maintenance, cost per ton.	Operation & Maint., cost per ton.
No. 1.	16,704 tons per mo. (av. of 12 mos.)	$0.0206	$0.0080	$0.0286
No. 2.	27,313 tons in one year, ending Sept. 30, 1908	....	.0005	....
No. 3.	37,102 tons, 1906	.0367	.0048	.0415
	46,283 tons, 1907	.0319	.0010	.0329
	49,325 tons, 1908	.0367	.00006	.03676
No. 4.	12,711 tons, 1906	.0299	.0002	.0301
	13,934 tons, 1907	.0323	.0017	.0340
	11,542 tons, 1908	.0352	.0009	.0361
No. 5.	10,910 tons, 1906	.0260	.0000	.0260
	13,970 tons, 1907	.0241	.0003	.0244
	9,416 tons, 1908	.0246	.0005	.0251

(3) The switching charges for handling both coal and ashes should be given and properly divided between the two.

(4) The costs should be tabulated for the various months, since they will, as a rule, vary at different seasons.

(5) The amount of each kind and size of coal handled each month, the amount of ashes handled each month and the number of engines coaled and cleaned each month.

6) Type of cars from which coal is unloaded.

COAL HANDLING.—At a large central station the work is usually divided up so that each man has his special duties, and in such cases the costs should be still further subdivided so that costs of the various operations can be compared. For instance, the cost of getting the coal out of the cars will vary with the type of car used, the kind of coal and the way in which the coal is handled as it leaves the car. With a trestle arrangement, fine anthracite coal can be discharged very rapidly from a hopper-bottom steel car, whereas with a conveyor arrangement with the usual size of track hopper it is necessary to allow the coal to feed through at the rate at which the conveyor takes it away. When only part of the car bottom is hoppered, there will be the same amount of time consumed in either case in cleaning out the coal which does not flow out by gravity. Where run-of-mine or large lump coal is handled, it will not flow out freely, and additional labor is necessary to get it out. Therefore it is important to know the cost of getting the coal out of the cars, as this may vary widely in two stations of the same design, if different types of cars or different kinds of coal are used. In fact, where it is possible, the cost should be subdivided so as to show the cost of each of the following items: (1) Getting coal out of cars; (2) labor for handling coal to pockets or other storage; (3) power for handling coal to pockets or other storage; (4) delivering coal to tenders; (5) switching; (6) supplies.

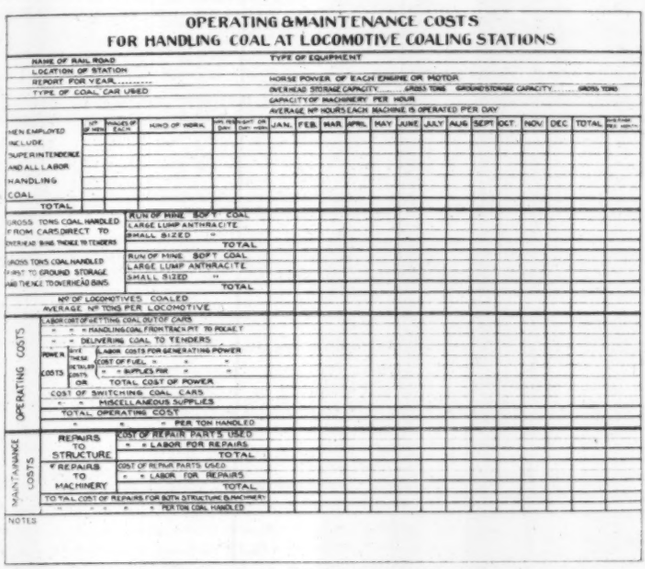
Some of these costs may be abnormally high in a certain case and yet not be due to the design of the station or type of equipment used but to the kind of coal handled, the type of coal car, the source of power, wages paid or some other conditions which are not universally the same. For purposes of comparison, therefore, it is necessary to have complete data.

ASH HANDLING.—In handling ashes, the costs should be divided as follows: (1) Cost of cleaning locomotives; (2) cost of delivering ashes to machinery; (3) labor cost of handling ashes to pocket and thence to cars, or direct to cars; (4) power cost of handling ashes to pocket and thence to cars; (5) cost of switching ash cars; (6) cost of supplies.

At some stations the cost of operations No. 1 and No. 2 are very hard to keep separate, as the same men are used for both, cleaning the locomotives as they come in and feeding the ashes to the machinery in between times. When they can be separated, however, both should be given, and they can be added together in case it is desired to compare them to costs at another station where they are not separated.

Suggested Form of Cost Record.

Fig. 1 shows a tabular form which is suggested for keeping records of the operating and maintenance costs in handling coal only. At the top of the form are spaces for giving a brief description of the station. Below this comes the record of wages paid, with spaces for the total wages paid each class of men for each month of the year and also the amount of superintendence chargeable to coal handling. Next comes the record of the amount of each kind of coal handled and the number of engines coaled and cleaned each month. Below this are the regular operating and maintenance costs for each month. In some cases it may not be feasible to subdivide the costs as they are subdivided in the table, but in such cases the total of several operations can be given and the headings bracketed together in the table. As a rule, however, it should be possible to at least approximate these subdivisions. Fig. 2 shows a similar form for keeping records of ash handling costs.

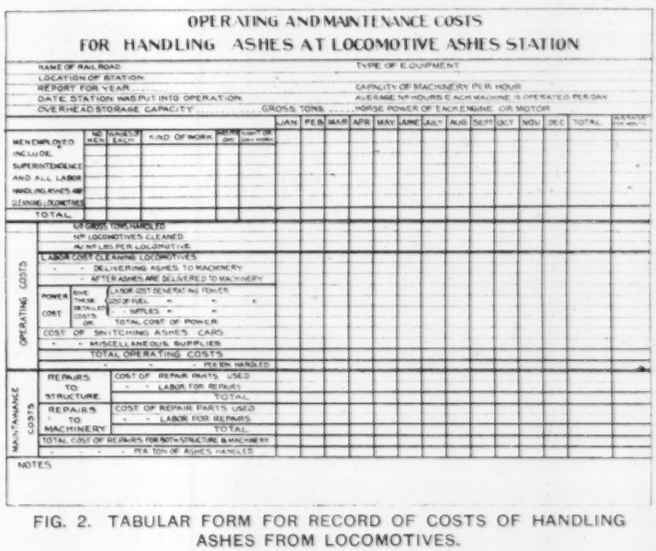

OPERATING & MAINTENANCE COSTS
FOR HANDLING COAL AT LOCOMOTIVE COALING STATIONS

NAME OF RAIL ROAD — TYPE OF EQUIPMENT
LOCATION OF STATION
REPORT FOR YEAR.....
HORSE POWER OF EACH ENGINE OR MOTOR
OVERHEAD STORAGE CAPACITY..... GROSS TONS GROUND STORAGE CAPACITY..... GROSS TONS
TYPE OF COAL CAR USED — CAPACITY OF MACHINERY PER HOUR
AVERAGE Nº HOURS EACH MACHINE IS OPERATED PER DAY

		No. of men	Wages of each	Kind of work	Unit of time	Weight or quantity of coal handled	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	Average per month
MEN EMPLOYED INCLUDE																				
SUPERINTENDENCE																				
AND ALL LABOR																				
HANDLING																				
COAL																				
TOTAL																				
GROSS TONS COAL HANDLED FROM CARS DIRECT TO OVERHEAD BINS, TROLLEY TO TENDERS				RUN OF MINE SOFT COAL																
				LARGE LUMP ANTHRACITE																
				SMALL SIZED "																
				TOTAL																
GROSS TONS COAL HANDLED FIRST TO GROUND STORAGE AND THENCE TO OVERHEAD BINS				RUN OF MINE SOFT COAL																
				LARGE LUMP ANTHRACITE																
				SMALL SIZED "																
				TOTAL																
Nº OF LOCOMOTIVES COALED																				
AVERAGE Nº TONS PER LOCOMOTIVE																				
OPERATING COSTS	LABOR COST OF GETTING COAL OUT OF CARS																			
	" " " HANDLING COAL FROM TRENCH PIT TO POCKET																			
	" " " DELIVERING COAL TO TENDERS																			
	POWER COSTS: GIVE THESE DETAILED COSTS OR — LABOR COSTS FOR GENERATING POWER																			
	COST OF FUEL " " "																			
	" " " SUPPLIES FOR " " "																			
	TOTAL COST OF POWER																			
	COST OF SWITCHING COAL CARS																			
	" " " MISCELLANEOUS SUPPLIES																			
	TOTAL OPERATING COST																			
	" " " PER TON HANDLED																			
MAINTENANCE COSTS	REPAIRS TO STRUCTURE — COST OF REPAIR PARTS USED																			
	" " " LABOR FOR REPAIRS																			
	TOTAL																			
	REPAIRS TO MACHINERY — COST OF REPAIR PARTS USED																			
	" " " LABOR FOR REPAIRS																			
	TOTAL																			
	TOTAL COST OF REPAIRS FOR BOTH STRUCTURE & MACHINERY																			
	" " " PER TON COAL HANDLED																			

NOTES

FIG. 1. TABULAR FORM FOR RECORD OF OPERATING AND MAINTENANCE COSTS IN COAL HANDLING AT LOCOMOTIVE COALING STATIONS.


OPERATING AND MAINTENANCE COSTS
FOR HANDLING ASHES AT LOCOMOTIVE ASHES STATION

NAME OF RAIL ROAD — TYPE OF EQUIPMENT
LOCATION OF STATION — CAPACITY OF MACHINERY PER HOUR
REPORT FOR YEAR — AVERAGE Nº HOURS EACH MACHINE IS OPERATED PER DAY
DATE STATION WAS PUT INTO OPERATION
OVERHEAD STORAGE CAPACITY..... GROSS TONS..... HORSE POWER OF EACH ENGINE OR MOTOR

		No. of men	Wages of each	Kind of work	Unit of time	Quantity of ash handled	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	Average per month
MEN EMPLOYED INCLUDE																				
SUPERINTENDENCE																				
AND ALL LABOR																				
HANDLING ASHES AND																				
CLEANING LOCOMOTIVES																				
TOTAL																				
	Nº GROSS TONS HANDLED																			
	Nº LOCOMOTIVES CLEANED																			
	AV. Nº LBS. PER LOCOMOTIVE																			
OPERATING COSTS	LABOR COST CLEANING LOCOMOTIVES																			
	" " DELIVERING ASHES TO MACHINERY																			
	" " AFTER ASHES ARE DELIVERED TO MACHINERY																			
	POWER COST: GIVE THESE DETAILED COSTS OR — LABOR COST GENERATING POWER																			
	COST OF FUEL " " "																			
	" " SUPPLIES " " "																			
	TOTAL COST OF POWER																			
	COST OF SWITCHING ASHES CARS																			
	" " MISCELLANEOUS SUPPLIES																			
	TOTAL OPERATING COSTS																			
	" " " PER TON HANDLED																			
MAINTENANCE COSTS	REPAIRS TO STRUCTURE — COST OF REPAIR PARTS USED																			
	" " " LABOR FOR REPAIRS																			
	TOTAL																			
	REPAIRS TO MACHINERY — COST OF REPAIR PARTS USED																			
	" " " LABOR FOR REPAIRS																			
	TOTAL																			
	TOTAL COST OF REPAIRS FOR BOTH STRUCTURE & MACHINERY																			
	" " " PER TON OF ASHES HANDLED																			

NOTES

FIG. 2. TABULAR FORM FOR RECORD OF COSTS OF HANDLING ASHES FROM LOCOMOTIVES.

TABLE IV.—ESTIMATED OPERATING COSTS FOR A LARGE LOCOMOTIVE COALING STATION.

(a) For handling 750 tons of coal per day.*

Items common to several systems.	Cost per day.	Cost in cts. per ton.
½ of foreman's time, at $66 per mo...	$1.10	
4 men to unload cars, 15c. per hr. 10 hrs per day	6.00	
1 day and 1 night coal dumper (to tenders) 15 cts. per hr., 11 hrs p. d.	3.30	
	$10.40	$0.015
Items pertaining directly to this system:		
1 man to run coal conveyors, $55 per month each	1.80	
15 HP. for 10 hrs. at 2 cts. per HP. hr.	3.00	.0075
Supplies	.50	
	$15.70	$0.025

(b) For handling 250 cu. yds. of ashes per day.†

Items common to several systems.	Cost per day.	Cost in cts. per ton.
½ of foreman's time at $66 per mo...	$1.10	
6 men to scrape and feed ashes to conveyors, 15c. per hr., 10 hrs. per d.	9.00	
	$10.10	$0.0404
Items pertaining directly to this system:		
1 day and 1 night man to run ashes conveyors, $55 per month each....	$3.60	$0.0184
Cost of 2 HP. for 10 hrs. at 2 cts per HP. hr.	.40	
Cost of supplies	.60	
	$14.70	$0.0588

*Two gravity discharge elevator conveyors.
†Two pivoted bucket carriers.

Cost Data Collected by the Author

Tables I. and II. give some figures obtained for large terminal stations. The coaling station No. 3 and ash station No. 2 are one and the same station, which is arranged to handle both coal and ashes. This is true also of coaling station No. 4 and ash station No. 3.

Table III. gives some figures for smaller stations. It is easily seen that the figures obtainable were very meager and that on this account and also because the accounts were not kept in the same way it is difficult to make any comparisons that are of much value.

Table IV. gives estimated operating costs for a large terminal coal and ash station. The coal is discharged from cars to two track hoppers, from which it is fed by means of reciprocating feeders to either one of two gravity-discharge elevator-conveyors, which deliver it to the bins. The ashes are discharged into long pits between the rails, and fed to two overlapping pivoted bucket carriers running underneath the pits and at right angles to them. These carriers deliver to an overhead ash bin, at one end of the coal pocket. The ashes, which are directly over the two carriers, can be fed to them by simply operating a gate, but to clean up the rest of the pits the ashes have to be scraped up to the feed openings. For this work the fire-box cleaners can be used almost exclusively, when they are not cleaning locomotives.

It would seem that this subject should be taken up by some association, such as the International Railway Fuel Association, or the American Railway Engineering and Maintenance of Way Association. Such an association, after going over the matter thoroughly, could adopt standard forms for keeping such costs, and recommend that they be used by the various railroads. In this way a great deal of valuable data could no doubt be obtained, and the methods of cost-keeping systematized. The forms given in this article are intended merely as suggestions, and are intended to cover broadly the various types of stations, including trestles. There will no doubt be other things which the railroad engineer would wish to incorporate, which have not occurred to the writer. In regard to trestle stations, the long approach tracks which are sometimes necessary, should of course be included in the first cost of the station, and the maintenance of same included in the maintenance cost to give a true comparison with the station that does not require them.

Mechanical Properties of Copper-Nickel Steels Made from Electrolytic Iron and Monel Metal.

An interesting research into the properties of iron alloyed with copper and nickel in minor proportions has been carried on by Prof. Charles F. Burgess and Mr. James Aston at the University of Wisconsin recently. The latest reported results deal with iron containing both copper and nickel, as obtained through the use of Monel metal* as an alloying material.

The results of tests of copper-steels and nickel-steels were reported by the same authors a short time ago in Bulletin of the University of Wisconsin No. 346 (March, 1910), where they were conveniently summarized in the two sets of diagrams, Fig. 1 and Fig. 2, each giving curves for unannealed and annealed specimens respectively. These diagrams show clearly that both nickel and copper strengthen the iron considerably, but that beyond a certain percentage they reduce the ductility very much, although at higher percentages again there is an improvement. For nickel the favorable range extends to about 8%, while 8% to 12% represents the unfavorable range. For copper the limit of favorable percentage is much lower.

These tests were all made on material produced from highly refined electrolytic iron, i. e., iron produced by electro-deposition from Swedish iron as a raw material. The electrolytic product is stated to contain only about 0.03% impurities. The carbon content being very low, it was thought that when nickel or copper were added the resulting alloys might be materially different from similar alloys made with ordinary soft steel or wrought-iron. However, it will be seen from Fig. 1 that for nickel at least the general results are much the same as those found by other investigators for nickel-steels.

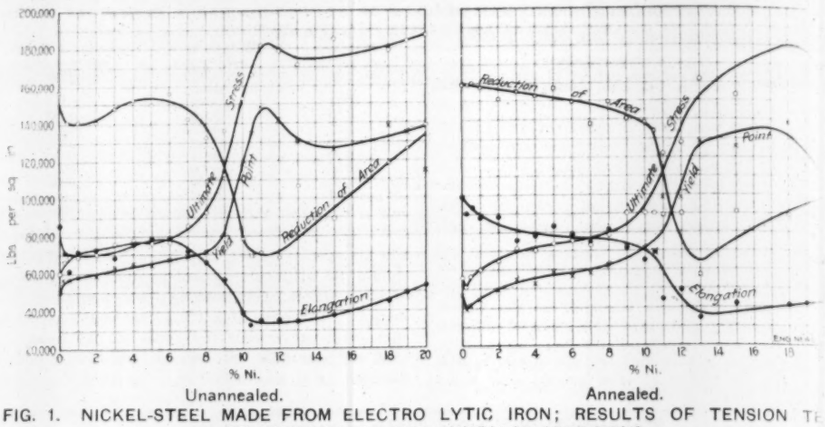
As the favorable ratio of nickel is much greater than that of copper, but on the other hand the price of nickel is higher, it was thought important to investigate what could be done with Monel metal as alloying material, inasmuch as this would supply a large percentage of nickel at substantially the price of copper. Tests were therefore made, with results as summarized in the diagram Fig. 3. These show that the resultant alloy has properties which may be considered the sum of the nickel effect and the copper effect.

It happens that the ratio of nickel to copper in Monel metal is about the same as the ratio of the most desirable nickel percentage to the most favorable copper percentage. Existing practice seems to favor a 3 to 4½% nickel-steel, and on the other hand for a copper-steel by Fig. 2 the amount of copper should not exceed 1 to 1½% if reduction of ductility is to be avoided. The most favorable percentage of Monel metal therefore is in effect the sum of the best nickel percentage and the best copper percentage; from Fig. 3 it may be taken as ranging from 4% to 8%.

In making these tests the electrolytic iron was broken into small pieces and melted with the proper quantity of alloy material in a magnesia crucible enclosed by a graphite jacket in an electric furnace. The charge was held above melting temperature for several hours and then allowed to cool slowly in the furnace. Ingots weighing about one pound were obtained in this way. They were forged out each into three test bars, which were machined in the lathe when possible (up to 12% alloy), or else ground, to uniform size about ⅜-in. diameter by 2 ins. free length. The specimens were tested in tension, some as forged and some after annealing at 900° C.

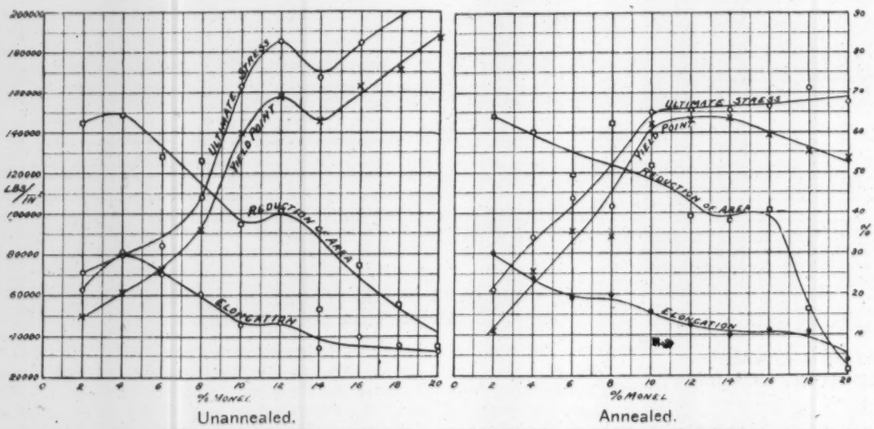
The authors' conclusions from the tests of the nickel-copper steels are stated in the following paragraphs, which refer to the two diagrams, Fig. 3:

UNANNEALED.—Between 0 and 8% there is a rather rapid rise in the ultimate strength and the elastic limit; the latter rises more rapidly, however, and at 8% the elastic ratio is 0.85, indicating brittleness. This is confirmed by the falling off in the values of elongation and reduction of area. Up to 4% of Monel addition



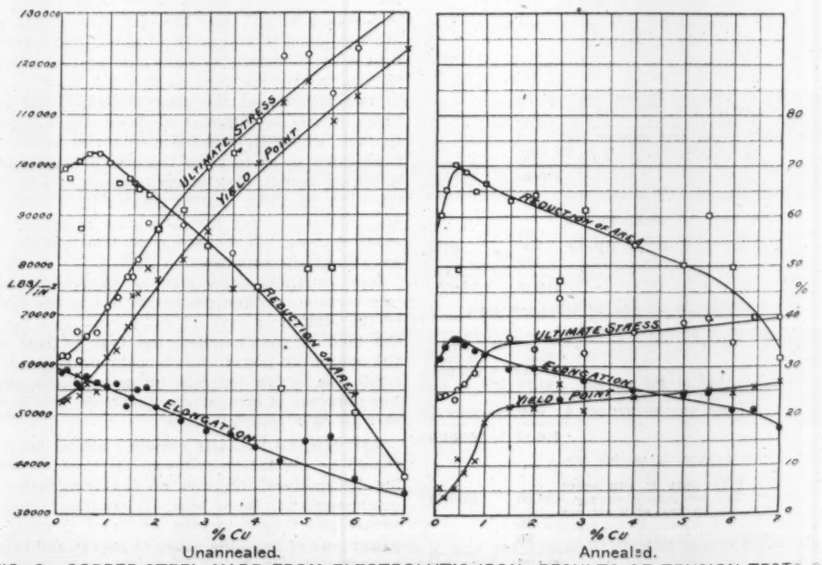
Unannealed. Annealed.

FIG. 1. NICKEL-STEEL MADE FROM ELECTRO LYTIC IRON; RESULTS OF TENSION TESTS OF UNANNEALED AND ANNEALED SPECIMENS.



Unannealed. Annealed.

FIG. 3. MONEL-STEEL (COPPER & NICKEL) MADE FROM ELECTROLYTIC IRON; RESULTS OF TENSION TESTS OF UNANNEALED AND ANNEALED SPECIMENS.



Unannealed. Annealed.

FIG. 2. COPPER-STEEL MADE FROM ELECTROLYTIC IRON; RESULTS OF TENSION TESTS OF UNANNEALED AND ANNEALED SPECIMENS.

*Monel metal, produced by direct smelting of the copper-nickel ores of the Canadian Lake Superior district, contains about three parts nickel to one part copper, with small percentages of iron and other elements. Its strength is equal or superior to that of medium steel.

there is an increase of ductility, and at this point we note the very fair values of ultimate stress 81,000, yield point 61,070, elongation 30%, and reduction of area, 64.3%.

From 8% upward there is a rapid increase in the maximum strength and elastic limit, but with ever-increasing brittleness, as is indicated by the steady falling off of the curves for elongation and reduction of area. The highest values reached for the series were for one of the bars with 18% of alloying addition, the figures being: Ultimate, 215,000; Yield point, 172,000; Elongation, 10%; Reduction of area, 27.6%.

ANNEALED.—In the alloys of lower Monel additions annealing has had but little effect on the properties. In fact the tendency has been to increase the ultimate strength and elastic limit without material falling off in the ductility. For those alloys with 4, 6 and 8% of addition (the probable useful range) the strength is higher. We now note an increase of ultimate stress and yield point in almost a linear function of the amount of alloying material until at 10% the values are: Ultimate, 150,000; Yield point, 144,400; Elongation, 15.7%; Reduction of area, 51.9%. The elongation and reduction of area are in accordance with the stress values.

Between 10 and 20% of Monel metal the ultimate strength undergoes but little variation, while the elastic limit becomes less with increasing additions. Strangely enough, the elongation and reduction becomes steadily less, the latter in particular falling off very abruptly at the higher percentages.

* * * * These results seem to warrant the conclusion that for the carbon-free alloys, at least, the combined addition of nickel and copper in the proportions found in the commercial Monel metal does not result in any deterioration of the good qualities conferred by the nickel alone; in fact, the copper has good inherent qualities of its own. Whether these same good features will result from like additions to commercial steels, with their customary amounts of impurities, is a problem now under consideration.

Prior to the tests with the Monel metal, similar alloys were made and tested in which pure copper and nickel had been added to iron, in practically the same proportions as Monel metal would have given. The results of this series were also reported in Bulletin No. 346, above noted. The curves do not depart greatly from those subsequently obtained with Monel metal, and it is concluded that the results exhibited by Fig. 3 are due directly to the copper and nickel additions contributed by the Monel metal.

The tests with Monel metal are reported fully in the August, 1910, issue of "Metallurgical and Chemical Engineering," from which we have taken our Fig. 3 and the above-quoted conclusions.

Forest Planting in Kentucky.*

By J. B. ATKINSON.†

Timber is as necessary to all mining operations as is labor. Twenty years ago the St. Bernard Mining Co., of Earlington, Ky., began to plant trees on lands that had largely been turned out as no longer valuable for the growth of tobacco and corn.

My experience as a mining man indicated to me that the time would come when timber would be far more valuable and difficult to secure for mining operations. During these 20 years, special attention has been given to finding the growth of the white oak; 45 white oaks of Hopkins County, grown on hills, in the valleys, and on the slopes between, were examined as to the ages when the trees reached 12 ins. diameter. The average age was found to be 101 years. The average age when cut was 231 years, with average diameter of 31 ins. The oldest tree when cut was 325 years old, with a diameter of 41 ins., and was 95 years growing to a diameter of 12 ins. The youngest was 142 years old when cut, with a diameter of 27 ins., and was 75 years growing to 12 ins.

From these facts collected I have made a table of the time it takes certain trees, in Kentucky, to grow to a diameter (at the stump) of 12 ins. This is not infallible, but is based on actual tree growth as observed in the forest, and has no reference to isolated growth, or to unusual conditions. The pine oak will grow to 12 ins. diameter in 40 years; black locust, 45; tulip, 50; black walnut, 56; Texas red oak, 58; sweet gum, 62; ash, 72; hickories, 90; white oak, 100 years.

The first tree planting was with the black walnut. The nut was planted in the autumn with the hull on, when the nuts became mature. The ground was prepared as for corn, and the nuts planted 4 ft. apart each way, or 2,770 to the acre, being covered with ½-in. to 1-in. of soil. The land was cultivated for three or four years the same as for corn, and then blue grass sown, the idea being that in 10 or 12 years the trees would be large enough to permit pasturage.

On the poorer of the thrown-out farm lands we plant black locust. This tree, belonging to the pulse family (the family of the clover and the peas), draws its nitrogen from the air and enriches the soils. We plant these trees 7 or 8 ft. apart each way, and cultivate as we do the walnuts.

We also plant the catalpa speciosa, a rapid growing tree from the Wabash valley. I have found this tree growing from 21 to 24 ins. in diameter at the stump in 38 years. It is spaced 7 or 8 ft., and cultivated like the walnuts for three or four years. The tulip tree, commonly called the yellow poplar, is a most durable tree, and should be planted on good land, the trees 10 ft. apart each way, or 435 to the acre.

Up to the present time, the above-mentioned four varieties are the only ones planted by us for the growing of new forests. From the autumn of 1888 to the spring of 1909, inclusive, my company has planted 430,000 black walnuts on 162 acres; 160,000 catalpa speciosa on 230 acres; 200,000 black locust on 280 acres; 10,000 tulip on 20 acres, and 850,000 black walnuts in vacant places in the forest, largely in bottom lands, a total planting of 1,650,000 trees.

The forest planting of walnuts 20 years ago has been thinned out until the stand is much less than 1,000 to the acre; 20 trees 25 to 35 ft. high, occupying 1,100 sq. ft., have now an average circumference of 17½ ins., or 5½ ins. diameter. The largest tree is 9.3 ins. diameter, the smallest is 3.4 ins. A young tulip forest, 11 years old from the seed, has produced trees 6 ins. in diameter.

When a natural forest is grazed, the cattle destroy much of the young growth, and my company is fencing its woodlands as rapidly as possible. The preserving of seed trees, together with fencing, will let nature do much to increase growth of present forests. Then reduce the cutting of timber to something below the annual growth, and a good beginning will have been made to restore Kentucky forests to their original glory. Besides this, there are tens of thousands of acres of cleared land in Kentucky that should be returned to the forest. Let the farmer select 10 to 20 acres of medium good land and plant it in walnuts and blue grass. A better or more profitable combination could not exist. On poor land, plant the black locust, and presently be possessed of a perpetual woodlot. On meadow lands plant catalpa speciosa, and again have a perpetual and quick growing forest.

Kentucky has too much land in so-called cultivation. Half the acres, well cultivated, would bring larger and better crops than are now secured. Hence the planted woodlots could be spared. The state has about half its area still covered with forest, and is in better condition to retain its present acreage and increase the annual growth than most of the states of our country. We are a patriotic people, but patriotism alone will not increase the production of our forests or add to its acreage. Legislation is required. If the commonwealth of Kentucky can protect its quail, it can protect its trees.

I believe the theory of free forests and revenue from the product of the forest may aid in the solution of the tax question. Then the man who plants trees would have an inducement. He would not be taxed on his growing crop until he sold his trees. The owner of forest lands would not be apt to cut immature trees, but await mature growth. One thing the American people may as well understand at once, there will never be cheap lumber again. A nation that cuts 3 ft. to 1 ft. that grows, as at present, will require generations of skilled forest management to increase the annual growth of the forests to meet the wants of civilized life.

*Abstract of a paper in the August number of "American Forestry."

†St. Bernard Mining Co., Earlington, Ky.

Floating Two Steel Tanks From Dry Tortugas, Fla., To Key West, Fla.

By DEWITT C. WEBB,* M. Am. Soc. C. E.

The Bureau of Yards and Docks, Navy Department, has recently completed the removal of two 200,000-gal. steel tanks from Dry Tortugas, Fla., to Key West, Fla. One of these tanks, called the "cistern," is 56 ft. in diameter and 11 ft. high, the other, called the "stand-pipe," is 25 ft. in diameter and 55 ft. high. Both have copper roofs on wood sheathing and steel rafters. The cistern weighs 56 tons and the stand-pipe 48 tons, both inclusive of roofs.

The tanks were located at Dry Tortugas about 150 ft. from high water mark and rested on grillages of I-beams supported by concrete foundations.

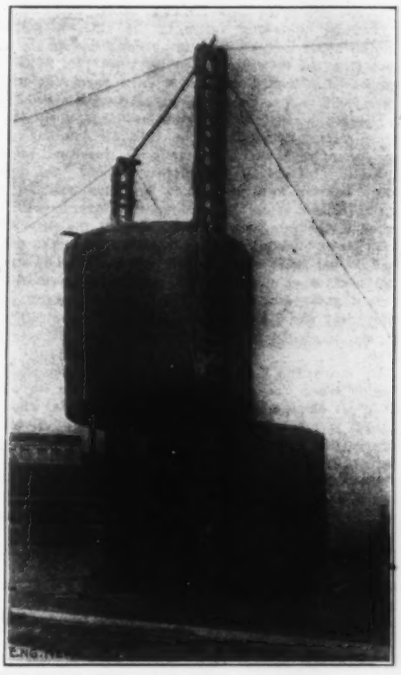
The distance from Tortugas to Key West is about 64 nautical miles, the westerly half of which is almost entirely unprotected from winds and currents and is seldom calm.

There were available for the work the large tug "Osceola" and several coal barges, the largest barge being 90 ft. long and 33 ft. wide. This barge was towed to Tortugas and ballasted with about 100 tons of coal. The cistern was jacked up and the steel beams removed. It was then lowered on rollers and run on the barge, where it was firmly secured. The overhang of the cistern (11½ ft. on each side) and the small freeboard of the barge made calm weather essential for a safe trip. On the first favorable day the tow left Tortugas and arrived safely at Key West in about 14 hours.

*Civil Engineer, U. S. N., Navy Yard, Boston, Mass.

At Key West the cistern was unloaded, rolled about 600 ft. and lowered on a concrete foundation previously prepared for it.

In moving the stand-pipe all the rivets in two horizontal seams—one 20 ft., the other 40 ft. from the ground—were first cut, enough bolts being inserted to support the weight of the tank. Braced wooden masts were then erected on each side of the stand-pipe, as shown in the accompanying half-tone. It was then lowered on rollers, the roof braced and lifted, the stand-pipe rolled back about 30 ft., and the roof lowered to the ground. This operation was then repeated with the two top sections of the stand-pipe.



Removing Second Section of Stand-Pipe at Dry Tortugas Preparatory to Floating It To Key West.

The top section was braced and turned on its side in the hope that it could be more easily handled in this position, but it was found that the bracing required made this method more expensive and troublesome and it was not followed with the next section.

After being taken down the several sections of the stand-pipe were loaded on two barges, towed to Key West and reassembled by the same method employed in taking them apart.

Traffic on the River Seine, France.*

Consul James E. Dunning, of Havre, in his annual report for 1909, describes the system of navigation on the Seine River, which connects not only Paris, but also the richest part of interior France with the port of Havre, and which is a striking example of a waterway combining the services of canal and river. The Consul says:

At Havre and from that port to Rouen, the system has a maritime aspect; from Rouen to Paris it is simply river; beyond Paris for nearly 130 miles it is canal or canalized river to the head of navigation at Mery-sur-Seine. Its total navigable length is 345 miles, and the canal of the upper Seine carries its waters 35 miles farther. The improvements made since the eighteenth century have cost more than $25,000,000.

From Mery to Marcilly (16 miles) the river is only nominally navigable and traffic is carried on in the Upper Seine Canal. From Marcilly to Montereau (42 miles) the river is entirely canalized and permits the use of barges drawing up to 4.55 ft. and less than 125 ft. in length; towage is by horses. From Montereau to Paris (60 miles) barges of 6 ft. draft, 125 ft. long, and of 15 ft. beam, can navigate, traffic being chiefly on 600-ton barges and steam vessels of 100 to 250 tons. There is direct railway connection at various points and at Paris extensive freight-handling facilities and terminals.

The principal improvement on the maritime section is

*From U. S. Consular Reports, Bureau of Commerce and Labor, Washington, D. C.

the canal from Havre to Tancarville, a distance of 15 miles. Through this waterway not only barges but steamers are able to pass into the safe water of the river without attempting the sometimes difficult conditions of current and tide prevailing at the mouth of the river. The terminal facilities at Havre consist of a basin 163 × 750 ft., a lock 98 × 587 ft., and a main fluvial basin 197 × 1,900 ft. Traffic in 1908 through this canal amounted to 1,620 boats up-stream, carrying 481,000 tons of goods, and 1,661 down-stream, with 117,000 tons, besides 60 scows going up and 49 returning.

COST OF TOWAGE—HEAVY COAL TRAFFIC.

The cost of towing varies in the different sections. On the upper sections over the short distances the rate runs from 0.5 to 1 ct. per ton light and 1 to 2 cts. per ton loaded. From Montereau to Paris towage up-stream costs 0.088 ct. per ton-mile for light barges and 0.37 ct. for loaded barges; down-stream traffic pays one-fourth these rates. Below Paris, on that division known as the lower Seine as distinct from the maritime section, different rates prevail for different sections. On certain short sections local companies have the business and operate under rates regulated by the Government. For example, the rate between the mouth of the Oise River and Rouen (105 miles) for barges with at least half a load is not more than a 3-ct. per ton-mile up-stream and 1 ct. down-stream; for barges with less than half a load rates are in proportion. Empty barges going either way pay 6½ cts. per mile if of less than 150 tons, 11 cts. if of 150 to 250 tons, and 16 cts. if over 250 tons.

An interesting fact is that on the Montereau-Paris section when the price of wheat at Paris rises above $1.70 per bu. the rate for towage of food-stuffs, wine excepted, is reduced 37.5%, and on the Oise River-Rouen section the up-stream rate is reduced 0.15 ct. per ton-mile under similar conditions.

About half the coal consumed in Paris reaches that city by canal. Rouen is one of the most important ports for the entry of coal shipped into France from England and Wales, that commodity constituting 60% of all the traffic passing up the maritime section of the Seine. Coal vessels from Wales, it is stated, can arrive at Rouen, discharge cargo, return to Wales, load, and reach dock again at Rouen in a period of eight days. Most of the coal is transshipped for Paris, being transferred from the steamers to light-draft barges for carriage through the upper sections of the river. In 1908 Paris received in this way enough coal to have filled 200,000 French railway cars. To accommodate this growing waterway coal traffic special yards have been built at Rouen and a new fleet of 1,100-ton barges placed in service, which draw 9 ft. and are able to reach Paris on the usual 10-ft. stage of water.

COMPARISON OF RAIL AND WATER RATES.

While between Havre and Rouen the Seine is an especially advantageous coal route, it is inferior for handling miscellaneous freight, but its influence on railway rates is highly important, and it has had a marked effect on the development of this part of France. The effect of the opening of the Tancarville Canal was to reduce freight rates from 20 to 60 cts. a ton. While in France the railroad rates and those on rivers and canals are fixed by the Government and there is no opportunity to study the result of natural competition, the following table shows the comparative cost, per metric ton [2,204 lbs.] of transporting various articles from Havre to Paris by rail and by water:

Article.	Rail rate.	Water rate.
Bacon	$4.41	$2.895
Beer, in casks	4.41	1.93
Butter	7.35	2.895
Cheese	2.895	2.509
Dry goods	4.23	4.825
Furniture, crated	8.86	4.246
Glass, window	1.93	2.123
Glassware, common	2.895	2.316
Iron, bar	2.123	1.64

Article.	Rail rate.	Water rate.
Lumber	$1.64	$1.544
Machinery:		
Farm, in parts	2.315	2.123
Other, cased	2.895	2.316
Potatoes	2.123	2.316
Shoes	5.98	4.246
Sugar	1.93	2.509
Wine, in casks	4.05	3.474

The rates by rail and water are the same for the following articles: Cement, $1.64; coal, $1.35; fertilizers in bags, flour, grain and molasses, $1.93. The distance by rail is 142 miles and by water 231 miles. Down-stream rates vary only slightly from these.

WIRELESS TELEGRAPH STATIONS are thus mentioned in a recent speech of the British Postmaster-General:

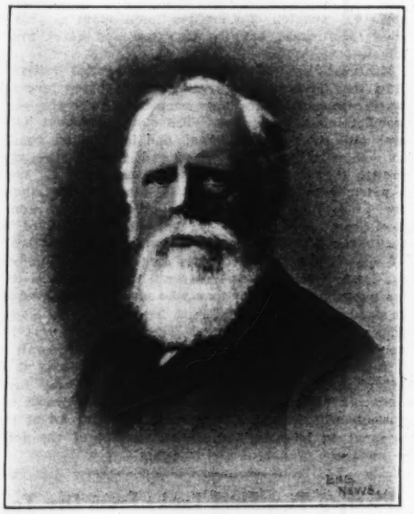
The purchase last autumn of the wireless telegraph stations round the coast had been fully justified by results. They are working with complete success. Within the last three months the number of messages received and sent has doubled. I hope before long to have a complete ring of stations all round Great Britain and Ireland.

Charles Talbot Porter.

Charles Talbot Porter, whose death occurred Aug. 28 at the home of his son in Montclair, N. J., was a pioneer in the introduction of the high-speed steam engine, being the co-inventor, with John F. Allen, of the Porter-Allen four-valve engine.

Mr. Porter was born in Auburn, N. Y., Jan. 18, 1826, and was graduated at Hamilton College in the class of 1845. He originally took up the profession of law, practicing as an attorney for about six years, first in Rochester, N. Y., and later in New York City. He first became actively interested in mechanics in connection with a stone-dressing machine invented by one of his clients. Mr. Porter and some friends bought the patent for this machine, but when a model of commercial size was made it would not work. Mr. Porter had put all his money into this enterprise and, rather than see it end in failure, set about to himself correct the defects in the design of the machine, of which he felt sure the main features were right. The machine eventually proved successful.

In working upon the design of the stone-dressing machine, Mr. Porter developed considerable interest and ability in mechanical engineering. It was the necessity of improving the governor of the engine which drove this machine that prompted him to the invention of the Porter governor, one of the essential features of the first successful high-speed engine.



Charles T. Porter

In 1862, Mr. Porter exhibited at the London International Exhibition an 8 × 24-in. engine which was run at 150 r. p. m. It had the valve gear invented by John F. Allen and was equipped with a Porter governor and the first high-speed indicator. The indicator was the invention of Charles B. Richards, from whom Mr. Porter had purchased the patent. Some difficulty was encountered in obtaining permission to run the engine at so high a speed, as it was considered unsafe. The usual speed of stationary engines at that time was about 50 or 60 r. p. m. In spite of the successful operation of the engine exhibited, it made but little impression because it was not arranged to run condensing. A non-condensing engine was not regarded seriously by the English engineers of that period, and it was assumed that it would be impossible to operate with a condenser and its accompanying pump at so high a speed.

An independent belt-driven air-pump, of which the speed was reduced below that of the engine by intermediate gearing, was devised by Mr. Porter, and in 1864 the regular manufacture of high-speed engines was begun in England. The first engines put on the market were manufactured, under contract, by Ormerod, G... Co., of Manchester.

At the Paris Exposition in 1867, Mr... exhibited five engines, one of which, with 12-in. cylinder, was speeded at 500 r. p. ... was equipped with a condenser and pump, ... maintained a vacuum of 28 ins., a vacuum ... was then considered astonishingly high. ... January, of the following year, 1868, Mr. ... presented a paper on the Porter-Allen ... before the British Institution of Mechanical ... gineers.

In June, 1868, he returned to America, ... an absence of about six years, and entered ... partnership with John F. Allen in the ... facture of their engine in a small shop ... Harlem, New York. The factory in Harlem ... operated until the fall of 1873, when the ... company's lease of the property expired and ... renewal was refused by the owner. On account ... of the financial depression of that year, it ... impossible to obtain the necessary capital ... the manufacture was discontinued. It ... recommenced, however, by Mr. Porter alone ... 1875 in the works of Hewes & Phillips in ... ark, N. J.

A few years later, a stock company was formed ... of which Mr. Porter was Vice-President in ... charge of manufacture. The engineering works ... of S. V. Merrick & Sons, known as the Southwark Foundry, in Philadelphia, were purchased by this company, which then, under the name of the Southwark Foundry & Machine Co., took up the manufacture of Porter-Allen engines. During the first six months at the new works, Mr. Porter evolved what was then a new system of filing and indexing mechanical drawings. This system he described in a paper presented before the American Society of Mechanical Engineers and published in Vol. II. of the "Transactions." This was one of the first of some fifty or more papers read by Mr. Porter before this society, of which he was a charter member.

Mr. Porter resigned from the Southwark Foundry Machine Co. in 1882 or '83, at which time its affairs had reached a critical condition owing to friction between Mr. Porter and its president, Mr. Wm. H. Merrick. The company was subsequently entirely reorganized and its business revived under the leadership of Mr. James C. Brooks.

In addition to papers presented before engineering societies, Mr. Porter was the author of "A Treatise on the Richards Steam-Engine Indicator and the Development and Application of Force in the Steam Engine," published in 1874; "Mechanics and Faith," 1885; and "Engineering Reminiscences," which appeared in book form in 1908. From the last-named book has been derived most of the material for the present brief account of Mr. Porter's career, and we are indebted to the firm of John Wiley & Sons, publishers, for permission to reproduce here the portrait used as the book's frontispiece.

Mr. Porter became a member of the American Society of Mechanical Engineers in 1880 and was one of those who presented papers at the first regular meeting in April of that year. He was elected Manager of the society in 1882 and Vice-President in 1886. He was made an honorary member in 1890. In 1909 he was awarded the John Fritz Medal for his part in the origination and development of the high-speed steam engine.

STREET LIGHTING TO ORDER.—Why should sober-minded citizens who are in their homes and safe in bed by 10 o'clock at night pay lighting taxes for others who, being of a jovial turn of mind, prefer to stay in cafes, clubs, or bars until midnight and do not reach home until the early hours of the morning? In Germany this question has now been answered. To the village of Zarkau, near Glogau, in Silesia, must be given the honor of installing a system of automatic electric lighting for the streets. The electric lights burn every night from the outskirts of Glogau through the village of Zarkau until 10 o'clock at a mutual cost to the community in general. Then they are switched out. At each end of this stretch, on an iron pillar, stands a small iron cupboard lighted by a tiny electric light. Those persons who are out after 10 o'clock wishing to have their way lighted must insert a 10-pfennig piece into a slot in the side of the iron cupboard. Then the nine lamps placed along this stretch burst forth for a twelve-minute life, thus enabling the passenger to find his way in lightness to his house.—New York "Tribune," Aug. 27.

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It is just a coincidence that we are able to chronicle in two successive issues such curious yet dissimilar instances of the instability of terra firma as the sudden caving at Staunton, Va., and the slow subsidence at Cambridge, Mass. The latter, recounted this week, is bare of spectacular elements, but its very slowness of action makes it rather the more interesting. For the Staunton phenomenon we have at least a plausable explanation: the washing and eroding action of groundwater in steep country. But no explanation is offered to account for the Cambridge subsidence. If a down-slope slip or sag of the earth on an inclined rock surface be supposed, it is not shown by any discoverable lateral shifting of the ground, we have been informed by Mr. Carter. And as the settlement in question covers a very limited region only, compressibility of the soil would not seem to be directly at fault. It will be interesting to learn whether similar subsidences have been observed elsewhere. In cities, where benchmark comparisons over extensive areas come about occasionally, any systematic alterations of levels would be likely to be discovered. We recall no similar case at the moment, however.

A radical change in the water-works service of Spokane, Wash., is desirable. The per capita consumption, already high in 1906, mounted to 245 gals. for 1909 and 271 for the first five months of 1910, according to a report of the Committee on Fire Prevention of the National Board of Fire Underwriters (135 William St., New York City). The report states that the friction loss in the force mains is "very high, since the domestic consumption is enormous, owing to inability to control it without the general introduction of meters." The distribution system lacks in size of main and subsidiary feeders and in gridironing and some of the laterals are too small. Only some 8% of the taps are metered. Naturally, an extension of the metering system is advised. Such a course, we may add, would lessen the evil effects of some of the deficiencies named and, by cutting pumping expenses, would aid materially in providing funds for strengthening the water-works system wherever needed. All this appears to be appreciated by the water-officials of Spokane, but not by city council.

The addition of a 1,392,681 population to a single city in a single decade, as the Census figures just announced show for New York, may well give rise to a serious reflection after the first flush of pride and wonder shared by the whole country has passed away. Think what this addition and the resulting total of 4,766,883 people in a single city means in this day of rapidly increasing demands upon municipal government! Remember, too, that while New York added 40% to its population and a far higher percentage to its municipal responsibilities, hundreds of other cities grew at a much more rapid percentage rate, so that it is safe to say that the country over municipal needs and responsibilities have increased a hundred per cent. in the last decade, while the increase in many cities and towns has been many times that rate. The added burdens incident to city growth fall upon every intelligent citizen, but the burden and privilege alike rest particularly upon the shoulders, the brain and the conscience of the engineer. Every day's new Census announcement of marvelous city and town growth should stimulate the engineer to greater and better-directed effort to meet his increasing opportunities and duties.

Defective fire hose is an all-too-common explanation of how many of the over-numerous fires which discredit American cities gain headway instead of being extinguished in their early stages. Oftentimes the hose is described as "old and rotten." Doubtless this is true in a considerable number of cases, but from a paper on fire hose tests published elsewhere in this issue it may be inferred that a large percentage of breaks is due to hose purchased under either inadequate specifications or without being subjected to proper test before acceptance. The whole subject is so thoroughly considered in the paper mentioned that we refer our readers to it for an exposition of the most common defects and the most obvious remedies.

It is only fair to repeat here that the hose tested was that classed by the manufacturers themselves as "minimum standard." Doubtless higher grades would show better absolute results under test, but whether they would show a higher percentage of specification compliance we cannot say. There is no doubt but what good hose can be obtained at good prices. The serious question is, how many cities are willing to pay the money for a good article and how many take adequate precautions to see that they get what they pay for, be the grade classed as high or low?

Finally, we wish to commend once more the admirable work being done at the Underwriters' Laboratories, in Chicago, where an able staff in a large, well-equipped building is engaged in making all sorts of tests in the interest of fire prevention.

The utilization of vacant lands for forest plantations has had but a small beginning in this country, although such work might well be made a valuable auxiliary to that of the protection of the existing forests. The experimental work of railway companies in establishing plantations as a source of supply for ties, fence posts and timbers has been described at different times in our columns, but in general this work has been spasmodic or unsystematic, on a limited scale, and with no very practical or encouraging results. Elsewhere in this issue we give some particulars of the work of a mining company in Kentucky which for 20 years has been utilizing abandoned farm lands for plantations. The work appears to have been carried on carefully and systematically, and there are doubtless many other places where such practical forestry work could be undertaken with advantage.

One of the great causes of the rapid reduction of forest resources is the enormous destruction and reckless waste of the timber (rather than the legitimate use and consumption), and the general neglect to undertake adequate methods of protection. As indicated by the paper mentioned above, it should be easily practicable for states to protect their forests, but as a matter of fact there appears to be little appreciation of the existing conditions on the part of the public, and in the absence of any strong public sentiment the legislatures are not likely to give the matter much consideration. It is true that some steps have been taken in this direction, mainly by the federal government, but these are only a small beginning toward either the protection or the renewal of the forests. The individual work is insignificant as compared with governmental work (slight as is the latter), but the practical and economic possibilities of such individual work are indicated by the paper in question.

In the announcement of the Third Ave. R. R., of New York City, that 30 small storage-battery cars are to be placed in operation is seen the completion of several months of comparative service trials to develop a self-contained motor vehicle to replace 25 old horse cars still operated by the company. The only other competing machine was a gasoline-electric motor car which seems to have operated satisfactorily from the mechanical standpoint. In Engineering News, May 12, p. 575, were presented all the data on these two types of cars then made available. From these data it appears that the gasoline-electric car was run at an average power cost of about 6.6 cts. per car mile. The storage-battery car of equal passenger capacity was reported to draw close to 0.56 KW.-hr. per car mile in service runs. From the meagre data available on the cost of generating electric power by the Third Ave. R. R. plants it appears that energy should be put into the storage batteries for not more than 3.3 cts. per KW.-hr., and, assuming a low charge-discharge efficiency of 65%, the power cost for the storage-battery car should work out to be 2.8 cts. per car mile. This gives a very favorable comparison with the similar figure of 6.6 cts., for the gasoline-electric car. The platform expenses should be the same for either type of car and these are reported as 7.5 cts. per car mile. The maintenance figures we may expect not to differ greatly as the trouble of charging the batteries tends to balance the heavy wear and tear of the ever-running gasoline engine. Such expense for the gasoline-electric car for one month was reported as 1.8 cts. per car mile.

Granting the foregoing assumptions as reasonable, the total cost of running these small storage-battery cars over the cross-town lines of this company then will be found to be some 12 cts. per car mile as against 15.9 cts. for the gasoline-electric type. Doubtless such cost considerations coupled with the quieter running of the storage-battery car influenced the decision noted. The further operation of these cars will be watched with interest as the reasons for their selection seem quite different from those which led to the transitory installations of similar cars on a few partially developed lines in New York city. As the history of these older attempts reveals many complaints about acid fumes and minor troubles, which are not yet forgotten, it may be assumed that the designers of the present cars believe that they have eliminated the sources of the old complaints. The older designers, too, believed that they had suppressed all possible objections, and if the new cars fulfill every expectation, a practical advance may be recorded.

In publishing and commenting on the "Conclusions" of the International Road Congress at Brussels, in our issue of Sept. 1, we failed to state that at the session of the Congress at which the Conclusions were adopted every delegate was in full dress, as they were obliged to be at all formal meetings of the Congress. Our readers are advised to reconsider the resolutions in view of the added weight given to them by this fact.

Track Development for High-Speed Train Service.

Is the present system of track construction capable of carrying traffic with higher wheel loads and higher speeds than at present? In what way may the track be strengthened to meet such developments in traffic conditions? Is there any necessity for or probability of a radical change in track construction to meet such conditions? These questions have been considered to some extent in this country, but they have been the subject of extended study and investigation on the part of European railway engineers. They were included in the subjects considered by the International Railway Congress, and some notes of papers presented at the recent meeting in Switzerland are given elsewhere in this issue.

The possibility of a marked increase in train speeds as a result of commercial requirements and of modern improvements in mechanical equipment, has been suggested many times. Such an increase has been made in individual cases, and there is evidence of a tendency towards a more general move in this direction. There has been, however, a still more marked advance in wheel loads. The capability of the track under such conditions may include the elements of safety and economy. The former implies a sufficient factor of safety to ensure that the track will not fail in such a way as to cause accidents. The economy refers to the relation between the first cost of strengthening and the continual cost of maintenance, together with the effect upon the total operating cost.

These questions apply almost exclusively to main lines of railways. From the information presented elsewhere it appears that track construction on such lines in Europe has always been of ample strength for the traffic, and that improvements have been made rather for purposes of economy in maintenance. It appears also that a large increase in the number and weight of freight trains (of relatively low speed) would be a greater cause for track strengthening than would an increase in the speed of fast passenger trains. This proposition is probably true also of this country, especially in view of the high wheel-loads of freight locomotives and cars, and of the fact that the track has a greater deflection or depression under these slower heavy trains. But on the other hand when a proposal is made to shorten the time of certain passenger runs or to put on new high-speed trains, the question as to the capability of the track must be taken into account not only in regard to safety but also in regard to the comfort of passengers.

The papers of the Railway Congress, to which reference has been made, indicate the extent to which European engineers have studied and analyzed the track (as a unit structure) with the principles of its design, and the forces to which it is subjected. In this connection we quote the following statement by Mr. Rosche (of Austria), which is based upon mathematical investigation and practical considerations:

> It is not possible to strengthen the track effectively by improving individual members, more especially by merely increasing the weight and moment of resistance of the rails; it is only possible to effect this by a uniform distribution of the resistance on all the members of the track and by strengthening them to a corresponding extent. . . The rail is the most expensive member of the track, and it becomes uneconomical to strengthen it unless a corresponding increase is made in the resistance of the track.

This view is undoubtedly correct, but it seems to us that it has not been sufficiently recognized in this country. Otherwise, we should see (on main lines) fewer instances of new rails laid upon old ties which have gradually shifted to an irregular spacing, which do not afford an even support for the rail or an efficient hold for the spike, and which lie in ballast of inferior quality and insufficient thickness. Probably this condition is due not so much to the engineering department as to the executive management, since the former is subject to the control and restrictions of the latter to a much greater extent than in Europe.

Consideration of the relation of track to traffic in regard to high speeds is of importance as to regular service rather than as to occasional special runs. As far as speeds in regular service are concerned, these range as high at 77¾ m. p. h. on the Northern Ry. of France, and 74½ m. p. h. on the Belgian State Railways. This means, of course, that much higher speeds are attained at certain points of the trip. In fact, for English railways it is considered that provision must be made for schedule speeds of 70 m. p. h. and actual speeds of 100 m. p. h. We doubt if any railway in this country has a schedule speed approaching 70 m. p. h., but actually speeds of 70 to 80 m. p. h. are made probably on certain parts of many fast runs. In Germany, there are said to be no regular trains making over 62 m. p. h., although the government regulations permit higher speed. This is said to be on account of economic reasons and "because there is no urgent need for higher speeds." The condition of the track is not a cause for this limitation, as much higher speeds have been made in experimental work; thus, speeds of 95¾ and 91½ m. p. h., have been obtained in trial runs on German railways.

Of course a few trial runs are not enough to prove that the track can sustain economically a regular service of this character. This point, however, is considered to be proved by the relations of track to speed on the Marienfelde-Zossen line, on which extensive experiments were made a few years ago. On that line, speeds up to 99½ m. p. h., were attained on 68.3-lb. rails, and the track showed little indication of failure; with 82.65-lb. rails, the speeds were increased to 130½ m. p. h., but again the track proved of ample strength. As many of the main lines in Germany have now 91-lb. rails and closely-spaced ties it is evident that they are capable of carrying any practicable speeds.

Train loads are probably higher in this country, although this might not apply to a comparison of short-distance trains made up of day cars only. Driving axle loads are certainly higher in this country, ranging up to 24 and 26 tons; in England the maximum is 20 to 22, while in France and Germany the limit is about 18 tons. On the other hand, such loads on a swiftly moving locomotive probably cause less deformation and have a less destructive influence than somewhat lighter loads of heavy freight locomotives moving at lower speeds. At any rate, we think there is no indication that first-class American track construction is not equal to any speed to which it may be subjected.

In the relation of track to high-speed traffic, European railways appear to have two points of advantage over American railways. In the first place, the high standard of tract construction applies to practically the full extent of the high-speed main lines in Europe, while in this country (with our great distances) a fast train making a run of any considerable length may travel over tracks of various degrees of quality. In the second place, the relation of axle loads to rail weight and track structure is probably lower, as a rule, in Europe. Thus, European railways have maximum axle loads of 15 to 20 tons on 80 to 100-lb. rails, operating mainly on track of high quality. In this country we have maximum axle loads of 20 to 26 tons on 75 to 100-lb. rails, operating on track of varying quality, with consequently greater depression of the track and a greater disturbing influence upon the ballast and individual parts of the track. In both cases the speeds may be from 60 to 75 m. p. h.

This appears to be one of the weak points of American railways. The railway system has, of course, a very large mileage of high-class track construction, but we believe that high-speed service is by no means confined to such track. We do not refer to mere weight of rail (which is probably ample in most cases), but to the track as a whole. In this respect, it seems to us that we have yet something to learn from foreign practice, and this view is supported by the numerous drawings of track construction which accompany the papers presented to the Railway Congress. Greater care is taken to obtain a proper spacing of ties relative to the loads carried. Heavy base plates serving as rail supports (both vertically and laterally) rather than as tie protectors, are in common use. Bolt and screw fastenings for the rails are used in great variety. At shoulder ties especially, we find in several cases an exceptionally secure fastening, heavy base plates being secured to the ties by screw spikes quite independently of the rail fastenings, which are bolted clips. With this arrangement, stress due to movement of the rail is exerted directly upon the bolts fastening the rail to the plate, and only indirectly upon the screws which fasten the plate to the tie. One object of such secure fastenings is to prevent deflection of the rail end from extending beyond the shoulder tie.

We do not mean to discuss the individual questions of rail joints and rail fastenings, or to suggest that foreign practice in these respects should be copied. But we do suggest that foreign practice indicates a track structure that is in some respects more substantial, and perhaps more economical, than much of the track carrying high-speed trains in this country. However this may be, it seems to us that what is needed on main lines of railway in this country is not so much the introduction of heavier rails or a higher class of track construction. Rather it is the more extended use of the present type of high-class track construction over a greater mileage, with ample attention to the maintenance of such track in condition suitable for the loads and speeds which it carries.

A point which is discussed by some of the foreign engineers in their papers is the application of the general considerations to the existing conditions. That is to say, the improvement of the actual track construction in individual cases. This point is not covered by the American author, and probably could not be touched upon with propriety. But it is the one important point to be considered by any American railway officer or engineer who has an opportunity to study the reports of the Railroad Congress.

The strengthening or improvement of the track for high-speed service may include the following: (1) A consolidation of the roadbed by drainage (and in exceptional cases by rolling or the application of new material of better quality); (2) the use of a heavy bed of ballast (European engineers recommend a depth of 15 to 18 ins. under the ties) of good hard stone, which will not settle by reason of crushing under the loads; this ballast to be thoroughly and firmly tamped under the ties; (3) the use of a bed of cinders or bottom ballast in order to increase the resistance of the ballast proper, especially when the roadbed is soft; (4) the use of heavy rails (probably 100 lbs. per yd. need not be exceeded), with special care to secure steel of high quality both as to strength and wearing properties; (5) careful design of joints with a view to supporting the rail ends, bracing them against lateral shocks and anchoring the rails rigidly to the shoulder ties; (6) fastening the rails tightly and securely to the ties and providing lateral support, as by grooved or shoulder tie plates; (7) providing ample tie bearing for the rails, the ties to be rigid and uniformly spaced, except that at the joints they should be spaced more closely in order to provide resistance to the severe stresses at these points. With any or all of these improvements must go ample work of maintenance to ensure that the original strength is maintained in spite of the effects of traffic.

Finally we may present the following conclusions: (1) no new or special type of track construction is necessary to make railways capable of safely and economically operating trains at very high speeds; (2) the present track construction in many cases needs to be strengthened to give a better relation with the traffic conditions; (3) it is worth while to see what can be learned from foreign practice in track construction.

A few words may be said as to this last conclusion, as it has been rather customary to assume that European engineers have developed an unnecessarily complicated and heavy track construction. The study of the work of others in lines similar to our own does not mean necessarily the copying of their work. The purpose is rather to see if their practice is better than ours in any way, and if our own practice can be

improved in the light of these observations. In an editorial review of the proceedings of the International Railway Congress, in our issue of Aug. 4, we pointed out the advantages of the opportunity for American railway men in meeting and conversing with similar officials of foreign railways. We might have mentioned also the opportunities of seeing what these foreign officials are doing. The railway engineer (or other officer) in these days cannot be content to see what his fellows are doing in this country, and wave aside foreign practice as not worth attention. It is safe to say that any such officer traveling abroad and using his eyes observantly may see many things which will not only attract his attention but may offer substance for serious thought and consideration.

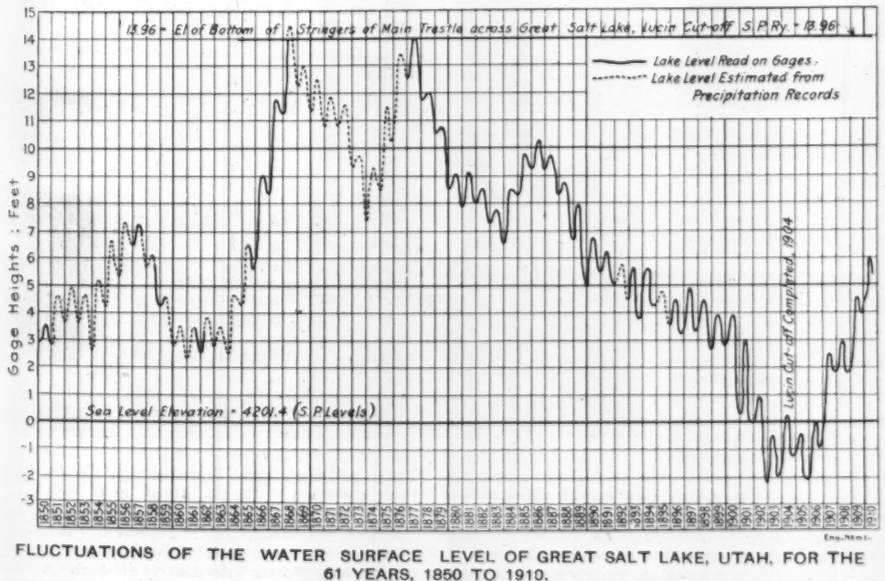
LETTERS TO THE EDITOR.

Changes in the Level of Great Salt Lake and the Lucin Cut-Off of the Southern Pacific Ry.

Sir: In Engineering News of Feb. 10, 1910, there appeared on page 183 a note on the recent rise of Great Salt Lake and its relation to the Lucin cut-off.

In view of the interest taken by the general public in the behavior of the Great Salt Lake in Utah, I submit the following reply to the note in order to correct several erroneous statements that appear in it.

During the years 1902 to 1905, feeling was general among the leading engineers of the West that Great Salt Lake was gradually drying up and that in a few years the lake would be replaced by a great salt desert. It is now very evident that this apprehension was unfounded. The accompanying diagram shows the actual lake levels for a period of 61 years, beginning with the year 1850. The lake level appears to rise and fall with a series of wet and dry years. The mean annual precipitation from 1886 to 1905 was 13.76 ins. The maximum annual precipitation during this period, 18.09 ins., occurred in 1891; the minimum, 9.37 ins., in 1887. The mean annual precipitation for the period 1906 to 1909, inclusive, was 20.97 ins.; the maximum, 23.35 ins., occurring in 1909; and the minimum, 19.36 ins., in 1907. It is very evident that the gradually falling lake level during the 21-year period beginning with 1886 was due to the low average precipitation of 13.76 ins. Furthermore, it is evident that the gradual rise in the lake level from 1906 to 1910 was due to the high mean precipitation of 20.97 ins. during this period. With the data available at present it would be impossible to determine to just what extent the diversion of the streams for irrigation has affected the lake levels.


13.96 = El of Bottom of Stringers of Main Trestle across Great Salt Lake, Lucin Cut-off S.P.Ry. = 13.96
Lake Level Read on Gages
Lake Level Estimated from Precipitation Records
Gage Heights : Feet
Sea Level Elevation = 4201.4 (S.P.Levels)
Lucin Cut-off Completed, 1904

FLUCTUATIONS OF THE WATER SURFACE LEVEL OF GREAT SALT LAKE, UTAH, FOR THE 61 YEARS, 1850 TO 1910.

(Prepared by E. C. LaRue. Based on information from Prof. Marcus E. Jones; Oregon Short Line R. R. Co.; U. S. Weather Bureau; U. S. Geological Survey.)

The note referred to says:

It now appears that the extraordinary inflow into Great Salt Lake has raised its level to a higher point than has ever been recorded since the country was settled.

This statement is very much in error. The diagram shows that the lake level for April, 1910, was approximately 6 ft. above the zero of the gage, and that for a period of 26 years, beginning in 1865, the lake stood above 6 ft. on the gage, reaching a maximum height of 14.5 ft. in 1868.

It is further stated in the note that "when the Lucin cut-off was constructed, the track was about 20 ft. above the lake level." The Lucin cut-off was completed in 1904. The mean lake level was then approximately —.5-ft. The bottom of the stringers of the main trestle over Great Salt Lake is 13.95 ft. above the zero of the lake gage. The bottom of the stringers, when the cut-off was constructed, was, therefore, approximately 14½ ft. above the lake level.

Although the Lucin cut-off has been damaged considerably by the rising of the lake, it will in all probability never be abandoned, for should the lake rise another foot or so, it will spread out over an immense flat and afford an enormously increased surface for evaporation, thereby checking the rise of the lake.

Owing to the extensive use of the water for irrigation within the Great Salt Lake drainage area, it is reasonable to believe that the lake will never rise above the 8-ft. mark again, as it has been well below this stage since the year 1888.

Very truly yours, E. C. LaRue,
District Engineer, U. S. Geological Survey.
Salt Lake City, Utah, July 7, 1910.

[We confess to possible hasty jumping at conclusions in connection with preparing the note in question, which was presumably based upon general information. We gladly give space to our correspondent's interesting figures, which illustrate anew the fact that well-kept records are of a thousand-fold more value than the recollections of the oldest inhabitant or the impressions of the new comer. The figures also show how misleading even the best of records dealing with meteorological and related conditions may be unless they cover a long period of years.—Ed.]

Engineering Societies and Professional Conduct.

Sir: In your able editorial comment of Aug. 18 you ask:

Why should not a great and influential body, in which engineers are joined together for the care of their common interests, devote part of its energies to questions that concern engineers as a whole that is to say professional questions? Is it not just as profitable to spend some time on discussion of rules or principles of professional conduct as to argue wordily over the precise degree of continuity probably prevailing in concrete beams?

In my opinion the reason is this: that while for purposes of acquiring learning and knowledge, engineers are a compact body, with common interests; for purposes of profesional conduct the membership of our great societies is not homogeneous. This membership is made up, very properly, of three groups of engineers: 1. Engineers paid a salary: employees; 2. Engineers paid from profits: contractors; 3. Engineers paid in fees by clients or holding responsible public positions.

The groups, while so closely connected in matters of learning and knowledge that the same engineer may at different times in his career belong to each group, are separated as widely as Alpha and Omega in their viewpoint as to professional conduct. And, speaking broadly, it will not be going too far to say, in matters known in law and medicine as professional ethics.

The members of the first group, constituting a majority of the membership, are little concerned by these matters. Dealing with a single employer they have little choice other than adapting themselves to the organization or getting out. Of course I do not refer to the ethics which should be common to all salaried employees, engineers or otherwise.

The members of the second group quite properly are concerned with business ethics rather than professional ethics.

With the third group, however, this matter of professional conduct toward the public, clients and toward each other is of vital interest and concern, not only to its members but to the public. Its influence and the esteem in which it is held depend directly upon this matter. And it is upon this group, relatively small in our large societies, that devolves the high duty of determining the engineer's attitude toward the public and (for here the law of action and reaction holds true) the esteem in which the public holds the engineer.

Such matters as: the duties of the engineer as an expert before our courts of justice, the nomenclature of the profession and the approval of engineers for responsible public positions—merely to choose three at random—would be profitable subjects for the attention of such a society as it is proposed to form in England. In fact something parallel to a Bar Association as you suggest.

The need for such an association is also here in America with us.

Very truly yours,
Charles H. Higgins.
Commercial Trust Bldg., Jersey City, N. J., Aug. 23, 1910.

Notes and Queries.

In a footnote to the article "The Physical Meaning of Entropy" in our issue of Sept. 1, p. 229, the address of the author, Mr. A. L. Menzin, was given as "Mechanical Engineer, 1535 East 60th St., Chicago, Ill." The proper address is "Mechanical Engineer, The Tracy Engineering Co., San Francisco, Cal."

A Roller Thrust Bearing Sustaining a Load of 2,250,000 lbs.

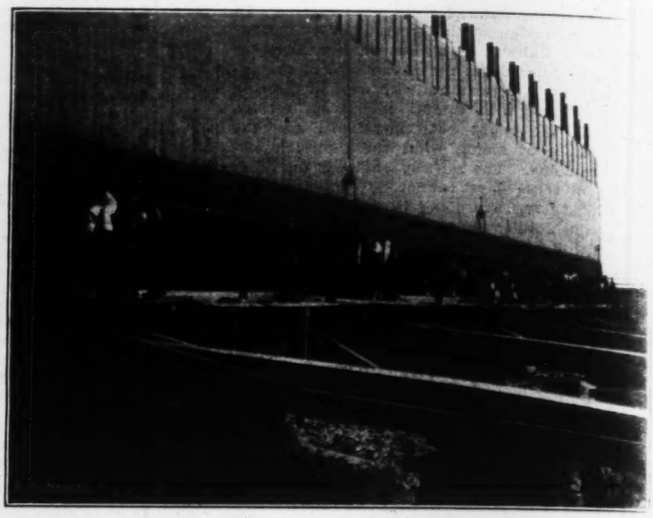
A large roller thrust bearing was recently installed at the Carnegie Steel Co.'s plant in Pittsburg, Pa., on a car wheel rolling machine. It was designed to sustain a total thrust of 2,000,000 lbs. at 100 r. p. m., and has been found able to sustain a load of 2,250,000 lbs. at that speed in regular operation. The load is hydraulically produced, and is intermitted, being applied for perhaps 30 seconds out of a minute. Conditions require that the machine be in operation 24 hours per day.

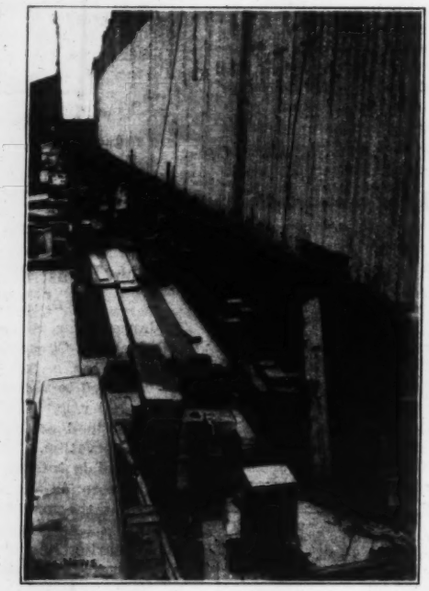
The bearing has plain cylindrical rolls. Conical rolls would theoretically give better results, but were rejected because of the difficulty of making them of uniform angle and diameter.

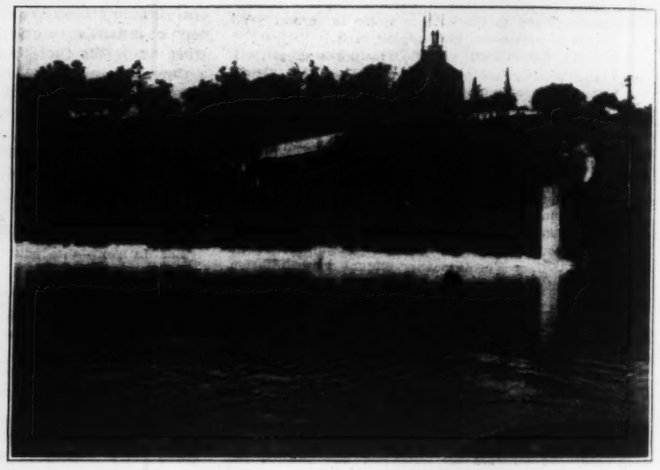
The roll cage is 6 ft. 5½ ins. in outside diameter, and the diameter of the hole for the shaft is 2 ft. 7 ins. The material of the cage is phosphor bronze, but heavy steel retaining bands encircle the bronze cage and keep the rollers in the radial slots. The cage has 24 of these radial slots, each of which contains four short rollers placed end to end. The rollers are made from a special alloy steel, and are 5 ins. in diameter. Variation in diameter along any one roller or between any two rollers is kept within ±0.0002-in. The end thrust of the rolls in their slots, due to centrifugal force and to frictional resistance to the constant deflection of the rolls from the tangential path which they tend to follow, is taken up by the steel balls, one at the end of each slot between the rolls and the retaining ring.

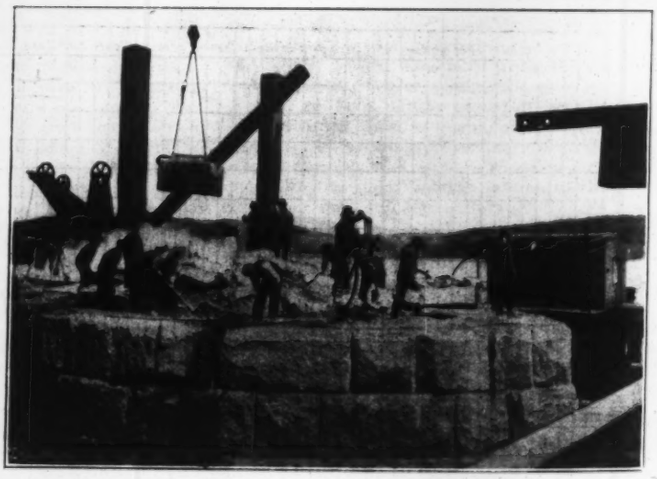
The roll cage runs between two parallel bearing plates or washers of forged steel, hardened and ground.

Uniform distribution of load on the bearing is insured by an additional pair of plates whose contacting faces are respectively convex and concave. They form a ball-and-socket base for the bearing and compensate any inaccuracy of alinement in the adjacent parts of the machine. The thrust bearing is combined with roller journal bearings for the 2-ft. 7-in. shaft. We are indebted for information for this description to Mr. T. F. Salter, Engineer of the Standard Roller Bearing Co., Philadelphia, Pa.









FIGS. 1-5. SUBSTRUCTURE WORK FOR THE NEW QUEBEC BRIDGE IN PROGRESS.

1. North Pier Caisson Being Built at Pointe a Pizeau; Launching Ways Nearly Completed. —2. Starting to Jack Down the River Edge of Caisson.—3. Jacks on Land Side of Caisson for Starting the Slide.—4. The Launching of the North Pier Caisson.—5. Demolishing the Old North Main Pier.

Caissons for the Main Piers of the New Quebec Bridge; Launch of the North Pier Caisson.

[Contributed.]

On July 7, 1910, the caisson for the North main pier of the new Quebec Bridge was successfully launched at Pointe a Pizeau, three miles below the site of the Bridge. It is one of the largest caissons ever constructed.* Since January the contractors, Messrs. M. P. & J. T. Davis, who were also the contractors for the old piers, have had from 200 to 300 men constantly employed on this work and at the present time the caisson is being sunk in position close against the old main pier.

When the old bridge collapsed in 1907, the masonry survived the shock excellently. Absolutely no movement of the South pier could be detected unless one notes an uplift of some quarter of an inch which the engineers claim to detect. When the reconstruction of the bridge was undertaken by a Board of Engineers appointed by the Government, it was hoped that it would be possible to utilize the old masonry. However, owing to the fact that it was considered advisable to make the new bridge some 21 ft. wider than the old, and that under the design proposed by the Board the new bridge will weigh nearly double the old, it was clearly evident that little or none of the existing substructure could be utilized. In fact, the only masonry that is available for the new work is part of the North and South abutments, and the foundations of the old South main pier.

NEW SOUTH MAIN PIER.—Neither of the old main piers was carried down to rock, but both rested on a hard foundation of gravel, sand and boulders. That the foundation on the south side was good was shown by the action of the pier at the time of the collapse. It was, therefore, decided to accept this foundation as satisfactory for the new pier and to utilize as much as possible of the existing masonry. The resulting arrangement is shown in the location diagram Fig. 6.

According to the official plans the old masonry will be taken down to the top of the old caisson, which contains a block of concrete masonry 49 ft. wide, 150 ft. long and 25 ft. in depth. This will form part of the new pier. To the south of this existing foundation and 2 ft. distant will be sunk an auxiliary caisson 25 ft. wide, 31 ft. deep and of the same length as the old caisson. Across the west end of both the other caissons, and 2 ft. distant, will be sunk a second auxiliary caisson 31 ft. wide, 85 ft. long and 27 ft. deep. The tops of all three caissons will have a uniform elevation (+ 42.64), about 40 ft. below ordinary low water. When this part of the work has been completed, a third caisson will be placed to cover the three lower caissons; this will be 180 ft. long, 79 ft. wide and 27 ft. high. It will be filled with a solid mass of concrete, heavily reinforced with steel, which it is expected will satisfactorily distribute the reaction of the pier to the three caissons below.

Above the third caisson will be constructed the pier, 58 ft. high, having an area of 39 ft. 6 ins. by 166 ft. 6 ins. at the base and 38 ft. by 165 ft. at the top.

*The two caissons of the towers of the Brooklyn Bridge over the East River at New York are: Manhattan caisson 102 × 172 ft., Brooklyn caisson 102 × 168 ft. The two caissons of the towers of the nearby Manhattan Bridge are each 78 × 144 ft.—Ed.

The bottom of the new caisson will go some 85 ft. below extreme high water or 66 ft. below the level of ordinary low tide. The base of the pier is to be at El. 70, 12 ft. below O. L. W., while the top will be at the same level as the top of the old pier, El. 128, which is 46 ft. above O. L. W. and nearly 27 ft. above extreme high tide in the river.

Owing to the presence of the wreckage on this side of the river, the removal of which is now under way, no work is being performed this season on this side of the river other than the demolition of the old piers (Fig. 5). The caissons will be constructed during the coming winter and the operations of sinking will start as early as possible in the Spring of 1911.

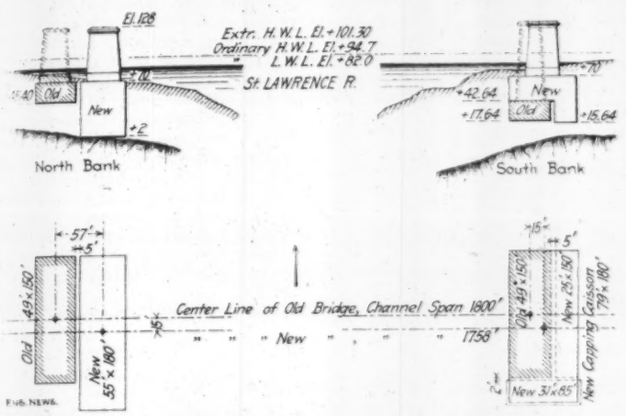


FIG. 6. LOCATION SKETCH OF OLD AND NEW MAIN PIERS, QUEBEC BRIDGE OVER THE ST. LAWRENCE RIVER.

NEW NORTH MAIN PIER.—The reduced length of span, 1,758 ft. as against 1,800 ft., brings the new north pier riverward of the old pier and clear of it. The foundation will, therefore, be wholly new (Fig. 6), and the old pier will be taken down to below low-water level, leaving its lower portion in the river. The facing stones will be re-cut and used in the new pier facing.

The new caisson is 55 ft. wide by 180 ft. long. Unlike the old caisson, whose base is on gravel at El. 45.40, the new caisson will be sunk to rock, whose surface is approximately at El. 2.0, making the caisson about 68 ft. high. At the time of launching (July 7) it had been built up to a height of 22 ft. 9 ins. above the shoe. Subsequently some 9 ft. more have been added before sinking operations were started, and the walls will be further built up as sinking progresses.

The great size of the caisson made the launching an important matter, the displacement of the "ship" being about 1,700 tons. Great care was taken in the preparations, and everything worked without a hitch. The working space was inclosed with a shed for winter work, but this was removed for the launching, as the photographs show.

The caisson [see the views Figs. 1 to 4] was laid down with its side parallel to the shore. Six rows of concrete piers, eighty-four in all, supported the launchways, each pier being carried down to rock. The launchways, set to a grade of 10.94%, were composed of two 12 × 12-in. timbers. When everything was ready the checks were removed and a slight movement given by means of jacks placed horizontally at the back. Only one or two of the jacks had gotten into action, however, before the caisson began to slide, and in a few seconds it had moved smoothly down the ways and into deep water. A false bottom of 3-in. planking, thoroughly calked, had been put in place just at the top of the shoe, and the working chamber filled with air, in order to give greater buoyancy when being launched and prevent any chance of grounding.

The walls of the caisson are built of 12 × 12-in. timbers. The shoe is composed of a single timber 30 × 30 ins. square, shod simply with a 6 × 12-in. plank. The corners are strongly reinforced with a steel plate. The roof is constructed over 18 working chambers, each approximately 20 × 25 ft. in area, separated by bulkheads of 12 × 12-in. timbers reinforced with two 2⅛-in. turnbuckle rods at each bulkhead. Communication between working chambers is easily effected by means of a manhole in each bulkhead. The roof is constructed of two layers of 12 × 12-in. timbers, with two layers of 3-in. tongue-and-grooved planking between them. All seams and joints in both roof and walls are calked with oakum, pitch, and tar, and made as nearly waterproof as possible.

Over the roof the caisson is divided into 90 open wells 9 × 10 ft. in area. Their bulkheads are mortised into the walls and will serve as bracing. They extend to a height of 25 ft. above the shoe; above this point to the top of the caisson the walls will continue as before, but will be braced against external as well as internal shear by means of a concrete retaining-wall built against the timber wall and battered out from the top towards the foot. Long bolts embedded in the concrete will run through the walls. This arrangement will do away with all further exterior timber bracing and allow the caisson to be filled with a solid block of concrete, thus increasing the weight and the sinking properties of the caisson.

Each working chamber is equipped with water pipes for loosening and removing the sand and gravel. Rock and other heavy material are lifted out through seven air-locks 3 ft. in diameter. All the working chambers will be lighted with electricity.

The air will be supplied by four large air-compressors driven by a battery of six 100-HP. boilers. A 12-in. pipe line carries the air from the air compressors to the caisson, cooling being done by laying the pipes in a trough of running water.

It is expected that the north caisson will be sunk to rock by the close of the present season. To gain time about 20 ft. of dredging has been done at the site of the pier, thus leaving some 50 ft. to be penetrated in about three months. It is recognized that the contractors will have to strain every nerve to finish in this time. Work is to be carried on with a full gang of men working twenty-four hours a day every day of the week.

When the caisson is finally in position, the bottom will rest some 97 ft. below extreme high water, so that its sinking ranks with the deepest pneumatic work in rivers, and is but little surpassed in depth by any pneumatic caisson work ever done.

THE SUPERSTRUCTURE.—The design of the Board of Engineers has been open to bidders for some months past. Bids on this design and alternative designs were asked early in the past summer, with the date of Sept. 1 for opening of bids. A few weeks ago the period was extended to Oct. 1. The Board design is shown in outline elevation by Fig. 7 herewith. The two trusses are spaced 88 ft. apart, and lie in vertical planes. The deck accommodates two 18-ft. roadways, two 15-ft. railway lines, and two 5½-ft. sidewalks.

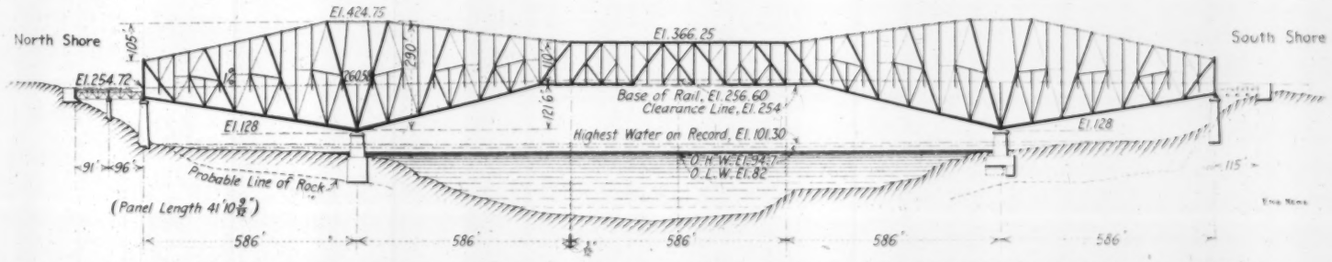


FIG 7. OUTLINE DIAGRAM OF TRUSSES FOR THE QUEBEC BRIDGE, UNDER THE DESIGN PROPOSED BY THE BOARD OF ENGINEERS.

Old Bridge: Main Span 1800 ft., Anchor Spans 500 ft., Total Length c. to c. 2800 ft.
New Bridge: Main Span 1758 ft., Anchor Spans 586 ft., Total Length c. to c. 2930 ft.

The Strengthening of Railway Track for High-Speed Traffic.

Among the subjects relating to track construction which were considered at the recent meeting of the International Railway Congress was that of strengthening the track to meet conditions of high-speed service, referring more particularly to higher speeds than those now in general use. Some notes from the four lengthy papers presented are given below as of interest in connection with possible developments in track construction in this country.

GERMANY.—Mr. Blum (of the Prussian Board of Public Works) arrives at the conclusion that strengthening of track for purposes of speed is not necessary on the main lines of European railways, the present track being amply able to sustain very much higher speeds than those now in use. It is true that during recent years there has been a considerable increase in the speed of trains, in the number of fast trains, and in wheel loads; also that the track design has been modified and strengthened. But on the other hand, the speeds and weights had been increased very materially before such strengthening had been undertaken, and without any indications that this latter was necessary to meet the new conditions.

In his opinion, the primary reason for strengthening the track (on German railways at least) is the increase in traffic, and especially in the number of freight trains, rather than the increase in speeds and wheel loads. Under the conditions of increased wear of the older track due to the greater traffic, the increased cost of a heavier track construction was relatively unimportant in view of the longer life and lower maintenance cost of this track. Furthermore, the wear and displacement of rail joints (which form the weak points) is less with fast passenger trains than with slow freight trains, while the wheels of the former are usually kept more truly circular and in better condition than those of the latter trains.

GREAT BRITAIN.—Mr. Jacomb-Hood (London & Southwestern Ry.) shows that in England, also, very great increases in speeds and loads and service have been made with practically no change in track construction. While 100-lb. rails are in use to some extent, the average main line rails are from 80 to 90 lbs. per yd., which is no considerable increase over the conditions of 30 years ago. As to further developments, locomotive axle loads have already exceeded 20 tons, and while the total weight may be increased, it is considered that (partly due to limitations as to the size of the engines) these maximum axle loads will not exceed 22 tons for many years. As far as speed is concerned, English railways may expect an average of 70 m. p. h. (including stops) for long runs with fast passenger trains, which will certainly involve maximum running speeds as high as 100 m. p. h. at favorable parts of the run. For these conditions, the present track construction is amply sufficient, provided (and this is an important matter to which we refer later) that it is maintained in good condition.

AUSTRIA.—The paper by Mr. Hermann Rosche, of the Aussig-Teplitz Ry., is of more than ordinary interest and value in that it is a treatise on track design, apart from its specific relation to Austrian railways. It discusses the general principles involved, and their application to actual conditions. Where strengthening is necessary, he recommends a general revision of the track in order to keep all its parts in proper relation as to strength and resistance. The ballast would be made deeper (in order to reduce the unit pressure upon the roadbed), and a better quality would be introduced in order to reduce the deformations resulting from settlement and disintegration. These latter points lead to the general use of hard stone ballast on European main lines, and its resistance is increased still further if laid upon a bottom bed of ballast instead of directly upon the roadbed. He recommends a minimum depth of 18 ins. under the ties, while Mr. Jacomb-Hood's paper gives 15 ins. of stone 1½ to 2½ ins. in size.

As to ties, he follows general European practice in advocating extreme length and width (8 ft. 10 ins. × 10¼ ins.), but appears to give less importance to the thickness. In this country the length rarely exceeds 8½ ft. (except under special conditions), and widths of 6 to 8 ins. are general. He admits, however, that the calculated superiority of long ties becomes less as the character of stability of the ballast increases.

As far as steel ties are concerned, he states that while many have been unsatisfactory, due to insufficient weight and stability, yet several modern designs are equal to or even better than wooden ties in regard to stability, quality of track, efficiency of rail fastenings and cost of maintenance. Their use, therefore, is merely an economic consideration. It is to be noted that the depression of ties in the ballast is less with high-speed than with low-speed trains (wheel loads being the same).

As to the rail, the improvement of the quality of the steel is considered of more importance than the increase in its weight. The joint is one of the most difficult problems, and while closely spaced ties (15 ins. c. to c. or 5 ins. clear with 10¼-in. ties) and double angle (or Z-bar) splices are advocated, stress is laid also upon the advantage of specially secure fastenings on the joint ties. These will afford lateral support to the rail end and also prevent the joint deflection from extending beyond the shoulder tie. In regard to the equipment, Mr. Rosche considers that the engines and cars for fast trains should be designed to produce as little dynamic action as possible, and that for speeds of over 93 m. p. h. tests should be made as to the dynamic action and the lateral forces exerted upon the track.

UNITED STATES.—In regard to American railways, the paper by Mr. M. L. Byers, M. Am. Soc. C. E. (Missouri Pacific Ry.), was given in abstract in our issue of Feb. 3, 1910. It presents the conclusions that while the permissible limit in track deformation decreases with the increase in speed of trains, the present type of track can be strengthened so greatly in proportion to any probable requirements of high-speed service, that the need of a radical change in type of construction is improbable. One way of strengthening is by increasing the sustaining power of the subgrade, but this is considered as too costly, except so far as it may be obtained by improved drainage. The other way is to reduce the maximum unit pressure on the subgrade, which may be effected by any or all of the following methods, according to requirements: (1) using rails of heavier weight and of high-grade or alloy steel, (2) spacing the ties more closely, (3) giving a greater depth of ballast, "and, of course, in extreme cases, by combining two or more of these means."

It is also to be noted that Mr. Byers makes no reference to rail joints or fastenings, which are touched upon as very important features by the other writers mentioned. He implies, also, by the phrase quoted above that the methods may be considered and employed independently, while the foreign writers lay more stress upon the necessity of considering and improving the track as a whole rather than in regard to its unit members. These methods of improvement will decrease the rate of deformation. The alternative is to increase the amount of labor applied to correcting the deformation (that is, the labor of track maintenance), with a view to keeping this deformation within the permissible limit. Where all these methods are not required, it becomes a problem in economics to determine which should be used.

CURVES.—The relation of the curvature of track to speed of trains is discussed in some of the papers, and it is notable that the matter of superelevation is considered relatively unimportant, as far as safety is concerned. The reduction of curvature is desirable where very high speeds are attained. But where this is practicable the best conditions call for (1) especially secure rail fastenings, (2) an extra amount of ballast on the outside of the curve, and (3) increase of the distance in which the superelevation is run out to the normal level. Special care must be taken to see that irregularities do not occur, but that the curve is kept uniform and even (both as to line and surface) in order to ensure steady riding of fast trains.

MAINTENANCE.—The importance of maintaining high-speed track in first-class condition is discussed in the papers. Mr. Jacomb-Hood states that the perfection of design in track may be neutralized by neglect to maintain such track in the best possible condition to meet the exacting requirements of heavy loads and high-speed service. Some of the writers point to a marked economy in cost of maintenance with heavy track construction, and a material reduction in the cost has indeed been experienced in some cases where the track has been strengthened. Mr. Rosche states that it is evident that a very strong track should cost little for maintenance, and that the question to be considered in each case is whether the increased expenditure on construction is in reasonable ratio to the saving effected in maintenance expense.

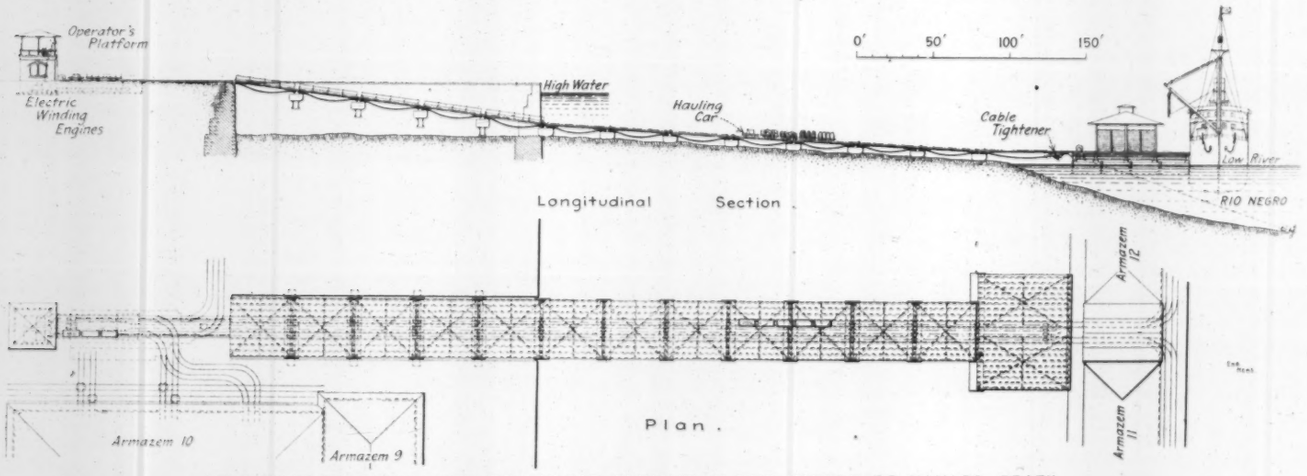
Mr. Jacomb-Hood is more conservative upon this point, though he believes that the strengthened track will produce an economy in total operating expense if not in the track maintenance expense. In fact, he states positively that a high degree in maintenance is to be recommended, even if the expenditure is greater than before.

It is important to note that all the writers lay stress upon the necessity of thoroughly tamping the ballast, as a part of the maintenance work, in order to compensate for the displacement that is occurring continually under the effects of traffic.

Freight Unloading System at Manaos, Brazil.

By CHARLES J. SEIBERT.*

From time to time articles have appeared in the technical press describing the port works at Para and Manaos, the rubber centers of Brazil, but there is an interesting feature of the harbor equipment at Manaos which seems to have escaped general notice. This is the floating ware-



FLOATING ROADWAY USED TO UNLOAD FREIGHT IN THE HARBOR OF MANAOS, BRAZIL.

house and the pontoon bridge which connects the warehouse with the quay wall.

At Manaos there is an annual rise and fall of the river amounting some times to 40 ft. difference between high and low water, so in order to obviate the use of lighters, at low river, in transferring cargo between steamships and the shore, the harbor company decided to anchor immense steel floats in permanently deep water and to maintain a fixed means of transportation between these floats and the quay wall.

The means used in the first floats placed

*No. 10 First St., Troy, N. Y.

operation was an overhead cableway with the head towers and winding engines located on the floats and the tail towers in bays between the warehouses on the shore. The more recent scheme, however, and one which allows the free passage of vehicles and passengers to steamers, is that illustrated by the accompanying plan and elevation.

The floating warehouses extend parallel to the quay wall for about 600 ft. and are erected on a float consisting of steel cylinders, flanged and bolted end to end in sets of four. These cylinders carry saddles on which rest the box girders which carry the framework for the deck of the float. Permanency of position is maintained by eight anchors, four chains passing from windlasses on the offshore side of the float to anchors placed inshore, and four chains passing from inshore windlasses to offshore anchors. Thus all chains pass under the float and by giving the end chains a diagonal direction the float is securely moored in all directions. As the river rises the chains are paid out and are taken up as the river falls. The changes in level are not sudden and no trouble is experienced in keeping the chains at the proper tension.

The pontoon bridge, or floating roadway, which connects the floating warehouse with the shore, consists of 13 spans of 42 ft. each. Each span consists of ten fish-belly plate girders, the ends of which are formed into hooks which fit over shafts running transversely with the length of the roadway; these shafts are supported on steel floats having a nearly rectangular shaped cross-section, as shown in the elevation.

At high river the whole roadway is level for its entire length, but as the river recedes, the floats fall until each finds its respective resting place on the exposed bottom, as shown in the elevation. The first four floats are then supported by steel girders which bridge a bay in the quay wall; the remaining floats rest directly on the breach. The grade at the steepest part is 12%, the roadway is 60 ft. wide and is decked with 4-in. planking.

For transferring cargo from ships to the upper warehouses an electrically driven tail-rope system of haulage has been installed. Cars of 2-tons capacity, running on a meter gage track, receive the contents of the slings from the ships' holds. These cars are then pushed by hand to a point at the foot of the roadway. Here the cars, which may be operated in trains of five, are coupled to a hauling car which is permanently fastened to the head and tail ropes. The cars are then hauled up the roadway, by winding engines, to a point beyond the switches running to the upper warehouses, the cargo cars are then uncoupled and distributed as desired. Downward bound cars are then received by the hauling car and a train is sent down to the foot of the roadway, where the cargo cars are uncoupled and pushed to the front side of the float to a point alongside the ship being loaded or unloaded.

The hauling cars themselves are in fact merely shuttles. These cars (there is one for each track) have vertically movable center-boards, or tongues, to which the wire cables, which haul the cars, are fixed. These cables are normally below the track level, but when the hauling car is at its upper position the ropes are above the track. Before uncoupling the trailers, a lever in the side of the hauling car is pulled out and the tongue drops, carrying the rope below the top of the track, thus giving a clear way over the switch for trailers, the wire rope having dropped into a slot below the rail head level.

The cars may be operated at a speed of 800 ft. per min. if desired, the operation of the winding engines being controlled by an operator stationed on the roof of the house which shelters the winding drums.

This latter equipment consists of two Lidgerwood 60-in. winding drums driven by G. E. ironclad, compound-wound motors, position indicators, upper and lower limit stops, and both hand and electro-magnetic brakes are provided. The speed is controlled by car type controllers.

The winding ropes are so arranged that one comes in on the same groove that the other leaves and a cable tightening device is placed at the foot of the roadway.

The floating roadway has been in operation for some six years. It carries in addition to the railway shown, the electric feeders for light and power for the floating warehouse, there being two electric locomotive cranes on the float, a triplex fire pump and a complete system of electric illumination. In these six years the roadway has never given any trouble, although sometimes heavy seas roll in from the river, which is four miles wide.

The present haulage system (which replaced the original grip system at first used) has been running about three years and has shown itself to be ideal for this particular work and locality.

A POWDER MILL EXPLOSION at Acton, Mass., Aug. 24, destroyed three of the American Powder Mills Co.'s buildings on the Acton-Maynard town line. One man, the night watchman, was killed.

A GUY DERRICK FELL at a Portland cement mill at Speed's Station, Ind., near Jeffersonville, Aug. 31, and three men were killed. The accident is ascribed to the failure of a guy rope.

FOREST FIRES IN WESTERN ONTARIO in Rainy River District have been revived by prolonged dry weather and high winds. Fort Frances and other towns in that vicinity both in Ontario and Minnesota are reported to have narrowly escaped destruction during the last week in August.

FLOODS IN SOUTHEASTERN NEBRASKA, due to a heavy rainfall Aug. 28-29, when 8 ins. of water fell in eight hours, according to press reports, caused the Blue and Nemaha rivers and numerous smaller streams to overflow their banks. At Lincoln, Neb., the Chicago, Burlington & Quincy R. R. yards were submerged and several trains stalled. Portions of the west end of the city were submerged to a depth of several feet.

THE STEAMSHIP "WATSON" WENT gently aground on a reef off Waaddah Island in Neah Bay, Wash., Sept. 1, in a fog. Her 92 passengers, bound from Seattle for San Francisco and Los Angeles, were taken safely ashore in open boats and continued their voyage next day on the "Buckman." The "Watson" is an 1,800-ton steel vessel owned by the Alaska-Pacific Steamship Co.

A BUTTING COLLISION at full speed between a limited and a local car on the Lake Shore Electric Ry. Sept. 4 wrecked both cars and injured 30 passengers, nine seriously. The accident occurred on a curve two miles east of Norwalk, Ohio, and is ascribed to negligence on the part of the motorman of the limited, who forgot a meeting order.

A HEIGHT OF 8,470 FT., was reached in an aeroplane at Beauville, France, on Sept. 3, by Leon Morane. At that height his motor failed to operate and he made a sensational glide of two miles to earth.

Glenn H. Curtiss made a flight of 60 miles over the shores of Lake Erie from Euclid Beach, near Cleveland, to Cedar Point, near Sandusky, on Aug. 31. The time of the flight was 1 hr. 18 min. The same biplane flyer was used which made the trip from Albany to New York City on May 29. The return trip, of Sept. 1, was made in the face of wind and rain and required 1 hr. 42 min.

NATIONAL GOOD ROADS CONVENTION.—The third annual convention will be held at St. Louis, Mo., Sept. 26-29.

THE NORTH SHORE DRAINAGE CHANNEL of the Sanitary District of Chicago is nearly 90% completed, and at the present rate of progress of the construction work it is expected that water can be turned into it during November. The channel extends from a lake intake at Wilmette to the north branch of the Chicago River. The total expenditure to date is $2,470,000. The total excavation amounts to 3,500,000 cu. yds. The average cost of the excavation, including extras and collateral diversion work, is only 20.2 cts. per cu. yd. At Wilmette, the harbor and dock work for the intake is completed, and the pumping station is nearly ready for the installation of the machinery. The contractors on about half of the channel have completed their work and removed their plant.

TELEPHONE AND TELEGRAPH COMPANIES in New York State passed under the jurisdiction of the Public Service Commission for the Second District on Sept. 1, in accordance with an act of the state legislature. All companies, corporations, associations, partnerships or persons owning or operating for profit telephone lines with a valuation of over $10,000 are included by the act, as are all telegraph companies. Schedules of all rates and charges, copies of all contracts and agreements between companies affording telegraph and telephone service. Companies are required to file an annual report. Under the act noted the Commission may make investigations, either after the receipt of complaints or upon its own initiative, and it has power to order repairs and changes. All franchise privileges hereafter granted to such companies must be approved by the Commission and the issue of stock and bonds must be with its consent. A New York City office has been opened in the Metropolitan Bldg., No. 1 Madison Ave.

A THOROUGH-GOING INVESTIGATION of express rates and of the "classifications, regulations and practices" of express companies engaged in interstate business throughout the United States is asked for in a carefully drawn petition recently presented to the Interstate Commerce Commission. The petition is signed by 124 mercantile associations distributed over the United States, headed by The Merchants' Association of New York, Boston Chamber of Commerce, The Chicago Association of Commerce, The Merchants' Exchange (San Francisco, Cal.), The Merchants' Association of San Francisco. The petition alleges excessive charges and a variety of other practices on the part of express companies which, in the opinion of the petitioners, are extremely prejudicial to business. Particular stress is laid upon the fact that owing to changes in business conditions, it has become necessary to substitute the express service for freight service to an extent which, due to excessive charges alleged, sometimes wipes out the profit in the business. In the course of the petition it is stated that "under the graduate scale" established by the express companies, "railroads receive for moving 100 lbs. in small parcels as high as 37½ times the amount received by them for moving 100 lbs. first class freight." This is said to be in part due to the fact that the express rates for long distances are multiples of short-distance rates, which latter include both terminal and haulage charges. Since the railroad companies are paid by the express companies on the basis of the gross receipts of the latter, the railroad companies make clear profit out of the multiple terminal charges, although no burden whatever is placed upon the railway companies on account of terminal or parcel delivery charges. The petition is signed by John W. Griggs, 27 Pine St., New York, and Benjamin L. Fairchild, 149 Broadway, New York, Counsel for Petitioners. Presumably, copies of the petition may be obtained by addressing the Merchants' Association of New York, 54 Lafayette St., New York City.

THE VALUE OF THE PROPERTY OF THE DENVER Union Water Co., Denver, Colo., has been estimated at about $6,400,000 by the Public Utilities Commission of that city, and the cost of a new plant, to be built by the city, has been estimated at $7,318,500. These estimates, we understand, are based on a report made to the Commission by Mr. Hiram Phillips, M. Am. Soc. C. E., St. Louis, Mo. The Public Utilities Commission was created not long ago as the result of the charter amendment carried at the recent municipal election, during which there was a heated contest over various waterworks propositions. In accordance with this amendment, the Public Utilities Commission was instructed to offer the company $7,000,000 for its plant. In case of non-acceptance of the offer the Commission was charged with the duty of building works, provided bonds for that purpose to the amount of $8,000,000 was authorized by an election which was to be called for Sept. 6 (see Eng. News, p. 763, June 30, 1910.) Shortly before the date set for the election just named, suit for an injunction to restrain the city from holding the water bond election on Sept. 6 was started by the New York Trust Co., as trustee for the bond holders of the Denver Union Water Co. The case was set for Aug. 31. From unconfirmed reports it appears that the injunction was not granted, the Judge apparently holding that the election could do the company no harm, and that it would be time enough to talk about an injunction when the city takes steps to issue bonds. The company claims that under the terms of the franchise of 1890 and certain city ordinances providing for the appointment of appraisers the city is legally bound to buy by the property of the Denver Union Water Co. at a valuation of $14,400,000, placed upon it by the board of engineers several years ago, or else grant the company a new franchise. As an alternative possibility, it was suggested that if the court should find the former appraisement illegal, then it would be the duty of the court to appoint a new board of appraisers to make an appraisal of the property of the company.

STANDING SEAMS FOR CORRUGATED ROOFING are obtained by the use of a new special fastening which does away with the necessity of rivets. Each section of roofing has one edge turned straight up for a width of a few inches, while the opposite edge is bent up and then doubled back so as to form a rounded slot or groove.

In laying the roof, the double, or grooved, edge of one width is fitted over the single upturned edge of the preceding section.

The fastening device is a strip of sheet metal which is bent into the form of a stirrup to fit around under the purlins. The two vertical legs of the stirrup are long enough to extend up above the purlin, one leg to a height about twice that of the seam in the roofing and the other to four times the seam height. The longer leg is doubled back on itself, making both legs appear of equal length.

After a section of roofing is placed in position, a stirrup is put around under the purlin and brought up against the edge of the section with its two legs extending above the single upturned edge. The shorter leg is simply bent over and down around the edge of the section, and the doubled leg is similarly bent except that the end of the strip which was formerly doubled back is left standing straight up. The next section of roofing is then applied with its grooved edge fitting over the upstanding edge of the section just laid and covering the bent ends of the stirrup, leaving exposed only the remaining upright end of the longer stirrup leg. This end is then bent down over the grooved edge and the seam is completed.

The fastening described is equally applicable to wood or steel purlins, and the work of laying the roof can be done entirely from above, without scaffolding. Some saving in the amount of roofing required for a given area is effected through the elimination of the lapping of two corrugations necessary when the seams are riveted. The form of roofing section and the fastening have been recently patented by the Edwards Manufacturing Co., Eggleston Ave. and Fourth St., Cincinnati, Ohio.

ANOTHER INVESTIGATION OF FERROSILICON has been made, this one by the Königliche Materialprüfungsamt of Berlin, Germany, supplementing prior analytical work by various continental investigators. The English conclusions, by the Local Government Board, were reported in our issue of March 17, 1910. They were, in brief, that it is desirable to prohibit the manufacture of grades between 30% and 76% Si., as in this range the dangers of hydrogen phosphide and arsenide liberation are greater than in either lower or higher alloys; that "pickling" the alloy by dipping in oil or paraffine should be prohibited; and that the makers should be required to store the ferrosilicon in the open for at least a month, to give time for elimination of the poisonous gases.

The German tests, by F. W. Hinrichsen ("Mitteilungen" of the Amt, 1910, V), covered five brands, running from 47% to 97% Si; all were electric-furnace products. They contained 0.02% to 0.08% phophorus, but no arsenic was found (whereas French and other analysts found that the ferrosilicon involved in specific instances of poisoning contained material percentages of As.). A test apparatus was arranged in which definite quantites of moistened air could be passed over a sample of the ferrosilicon, the outgoing air being analyzed. In every case hydrogen phosphide was found; successive charges of moistened air brought off decreasing amounts, but usually after letting the whole stand for a few weeks a much-increased evolution was obtained. The total quantity of phosphorus extracted as hydrogen phosphide was only a small part (1% to 6%) of the phosphorus existing in the sample. It was concluded that most of the phosphorus exists as iron phosphide (not readily split up by moist air), the remainder probably being in the form of calcium phosphide (readily dissociated). Tests for calcium showed much more than enough to account for amounts of calcium phosphide corresponding to the gas generated; the investigator assumes that the excess was bound in calcium silicide, etc.

There are no regulations governing manufacture or transport of ferrosilicon in Germany. Hinrichsen thinks such should be established (possibly also international rules). He approves of the Local Government Board recommendations, though his tests are too few to form a basis for discriminating between different percentages of the alloy as regards danger.

A REINFORCED-CONCRETE CAISSON BREAKWATER is to be built in Racine Harbor, on Lake Michigan, by the United States Government. The caissons to be used are of the type devised by Major Judson and described by him in an article in Engineering News, Oct. 15, 1908, p. 421. The breakwater consists first of about 800 ft. of pile pier, at the end of which is over a thousand feet of concrete caissons running into a breakwater already in existence in the outer harbor. The caissons are 26 in number, all rectangular in horizontal and vertical section, with transverse walls. Thirteen caissons are to be 36 ft. long, 20 ft. wide, and 18 ft. 3 ins. high, with two transverse walls; the side walls of these are to be 14 ins. in thickness, the end walls 17 ins., the transverse walls 10 ins., and the bottom 18 ins. Six caissons are to be 54 ft. long, 18 ft. wide and 15 ft. 3 ins. high; the outside walls of these caissons are to be 14 ins. in thickness, the transverse walls 10 ins., and the concrete bottoms 18 ins. Seven caissons are to be 36 ft. long, 15 ft. wide and 12 ft. 3 ins. high, with two transverse walls; the outside walls of these caissons are to be 12 ins. in thickness, the transverse walls 10 ins. and the bottom 16 ins. All walls are to be reinforced with 1-in. sq. bars near the outer and inner faces in both directions. According to the specifications, the caissons are to be made in forms furnished by the Government at any place along shore, and are to be towed by the U. S. Government to their proper place. When at the site they are to be sunk on a pile footing and then filled with broken stone for a depth of 9½ ft. On the top of this stone filling a base of lean concrete is to be filled in to the top of the caisson and above this a regular concrete breakwater superstructure is to be built. One novel feature of the design is that the lean concrete topping to the caisson filling is to be supported not only on the stone filling, but also on timber columns or posts placed inside the caisson before the stone filling is made.

Personals.

Dr. J. A. Holmes, M. Am. Inst. M. E., of the U. S. Geological Survey, has been appointed Director of the new Bureau of Mines.

Mr. Alburto Bement, M. Am Soc. M. E., consulting mechanical engineer, Chicago, was married on Aug. 23 to Miss Eva Henderson, at Berkeley, Cal.

Mr. W. C. Calvert, a civil engineer and surveyor of Burley, Idaho, has been appointed City Engineer of that place and placed in charge of street paving operations.

Mr. Edward T. Adams, M. Am. Soc. M. E., has resigned his position as Manager and Chief Engineer of the gas and mill engine department of the Allis-Chalmers Co., of Milwaukee, Wis.

Mr. D. C. Wedgeworth, Assoc. M. Am. Soc. C. E., has been appointed Resident Engineer on the construction of a section of the New York Barge Canal, with headquarters at Syracuse, N. Y.

Mr. A. S. Zinn, M. Am. Soc. C. E., Resident Engineer of the central division of the Panama Canal, sailed for Europe Sept. 3, on the "Kaiserin Auguste Victoria" to inspect the Kiel and Manchester ship canals and to visit other places of interest. He will return to the Isthmus the latter part of October.

Mr. Charles H. Pierce, who has been Assistant Professor of Mechanics and Railway Engineering at the University of Vermont for the past four years, has been appointed Assistant Engineer in the water resources branch of the U. S. Geological Survey. He will be stationed at Honolulu, Hawaiian Islands, for a study of the water resources of that territory.

Mr. T. L. Schubert, a civil engineer of the Royal Technological University of Stockholm, Sweden, was in this country during the months of August to inspect materials and methods of reinforced-concrete construction in the interest of the institution with which he is connected. Mr. Schubert spent several days in New York, Chicago, San Francisco and Los Angeles.

Mr. Henry A. Symonds and Mr. Edmund M. Blake have suspended indefinitely the partnership which formerly maintained civil engineering offices at 8 Beacon St., Boston, Mass., under the firm name of Blake & Symonds. Mr. Blake has removed for the present to Boise, Idaho, where he has taken up work in connection with certain engineering projects. Mr. Symonds has opened an office at 79 Milk St., Boston, and will continue practice as a consulting and constructing engineer, giving special attention to hydraulic, sanitary and municipal engineering.

Obituary.

Charles Anthony Goessmann, Professor Emeritus of Chemistry at the Massachusetts Agricultural College, died Sept. 1 at Amherst, Mass. Dr. Goessmann was born in Naumberg, Germany, in 1827, and received the degree of Ph. D. from the University of Goettingen in 1853. He came to this country in 1857 and became the manager of a sugar refinery in Philadelphia. He was Professor of Chemistry at the Rensselaer Polytechnic Institute in 1866-'68 and had held his last position, at the Massachusetts Agricultural College since 1869. He had been chemist to the Massachusetts State Board of Agriculture since 1873 and Analyst for the State Board of Health since 1886. Dr. Goessmann was a member of the American Chemical Society, of which he served as President in 1886-7.

Frederick Augustus Genth, Jr., chemist, of Philadelphia, Pa., died at his home in Lansdowne, Pa., Sept. 2, at the age of 55 years. Professor Genth was graduated at the University of Pennsylvania in geology and mining in 1876 and took a master's degree in chemistry from the same school in 1878. He was Assistant Chemist for the Pennsylvania Geological Survey from that time until 1881 when he returned to the university as an instructor, and later Assistant ... fessor in analytical chemistry. Subsequently he ... some time abroad, serving as private secretary to ... Kelvin at the University of Glasgow. In 1897-19... was chemist for the Pennsylvania Department of ... culture, and the pharmaceutical examining board ... same state. At the time of his death, Professor ... held the chair of mineralogy and assaying at ... Medico-Chirurgical College in Philadelphia. He w... member of the American Chemical Society, the Deu... Chemische Gesellschaft, the Société Chimique de ... and the British Society of Chemical Industry.

Engineering Societies.

COMING MEETINGS.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 13-16. Annual convention at St. Louis, M... Secy., A. P. Dane, Reading, Mass.

ROADMASTERS AND MAINTENANCE-OF-WAY ASSOCIATION.
Sept. 13-16. Annual convention at Chicago, Ill. Sec... Walter E. Emery, Chief Engineer, Peoria & P... Union Ry., Peoria, Ill.

COLORADO ELECTRIC LIGHT, POWER AND RAI... WAY ASSOCIATION.
Sept. 21-23. Annual convention at Colorado Sprin... Secy., J. C. Lawler, P. O. Box 938, Colorado Sprin...

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 21-23. Annual convention at Rochester, N. ... Secy., Willard Kent, Narragansett Pier, R. I.

NATIONAL IRRIGATION CONGRESS.
Sept. 26-30. Annual meeting at Pueblo, Colo. Secy... Arthur Hooker, Pueblo, Colo.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.
Oct. 10-14. Annual convention at Atlantic City, N. J... Secy., H. C. Donecker, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 11-14. Annual convention at Erie, Pa. Secy., A. P. Folwell, 239 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 11-13. Annual meeting at Richmond, Va. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN ELECTROCHEMICAL SOCIETY.
Oct. 13-15. Annual meeting at Chicago, Ill. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 18-20. Annual convention at Denver, Colo. Secy., C. A. Lichty, Chicago & Northwestern Ry., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 19-21. Annual meeting at New York City. Secy., A. B. Beadle, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 21-Nov. 15. Canal Zone meeting. Secy., R. W. Raymond, 29 West 39th St., New York City.

ILLUMINATING ENGINEERING SOCIETY.
Oct. 24. Annual convention at Baltimore, Md. Secy., P. S. Millar, 29 West 39th St., New York City.

OAKLAND ARCHITECTS' ASSOCIATION.—An organization under this name was effected Aug. 24 by prominent architects of Oakland County, Cal., with the idea of uniting to secure revision of building laws. The new association is to be allied to the American Institute of Architects. Officers were elected as follows: President, Louis J. Stone; Vice-President, J. C. Newsom; Secretary, W. J. Wright.

IRON AND STEEL INSTITUTE.—The autumn meeting will be held at Buxton, England, Sept. 26-30. Among the papers to be presented are the following: "The Theory of Hardening Carbon Steels," C. A. Edwards, Manchester; "The Influence of Silicon on Pure Cast Iron," A. Hague, Birmingham, and T. Turner, Birmingham; "The Utilization of Electric Power in the Iron and Steel Industry," J. E. Schuurman, Badin, Switzerland; "The Briquetting of Iron Ores," C. de Schwarz, Liége, Belgium; "Some Experiments on the Fatigue of Metals," J. H. Smith, Belfast.

ATLANTIC DEEPER WATERWAYS ASSOCIATION.—The third annual convention was held at Providence, R. I., Aug. 31-Sept. 2. Many men prominent in political and business circles spoke at length upon the value and desirability of the "chain of inland waterways from Maine to Florida," the construction of which by the Federal Government it is the object of this association to obtain. Officers for the ensuing year were re-elected as follows: President, J. Hampton Moore, Philadelphia; Secretary-Treasurer, Addison B. Burk, Philadelphia. Richmond, Va., was chosen as the place for the next convention.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—The "question box" has been put under the direction of a special editor, and the services of Mr. M. S. Seelman, Jr., have been secured for this position. Mr. Seelman has been associated with the advertising and other departments of the Edison Electric Illuminating Co. of Brooklyn for the past nine years. In 1906 he was awarded a prize of $500 offered by the Cooperative Electrical Development Association for the best paper on the organization and conduct of a new business department suitable for central stations in cities of not more than 50,000 inhabitants.